INTER AVIA

Review of World Aviation

In this Issue:

War Weariness and Air Force Budgets

Devon Francis : The Helicopter — Promise and Contradiction

Aerodynamics of the Swept-Back Wing — M. Moine : Large Flying-Boats — Arcata

G. Guanella : Sperry Microwave Instrument Landing System

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Aviation Economics

VOLUME II No 9 SEPTEMBER, 1947

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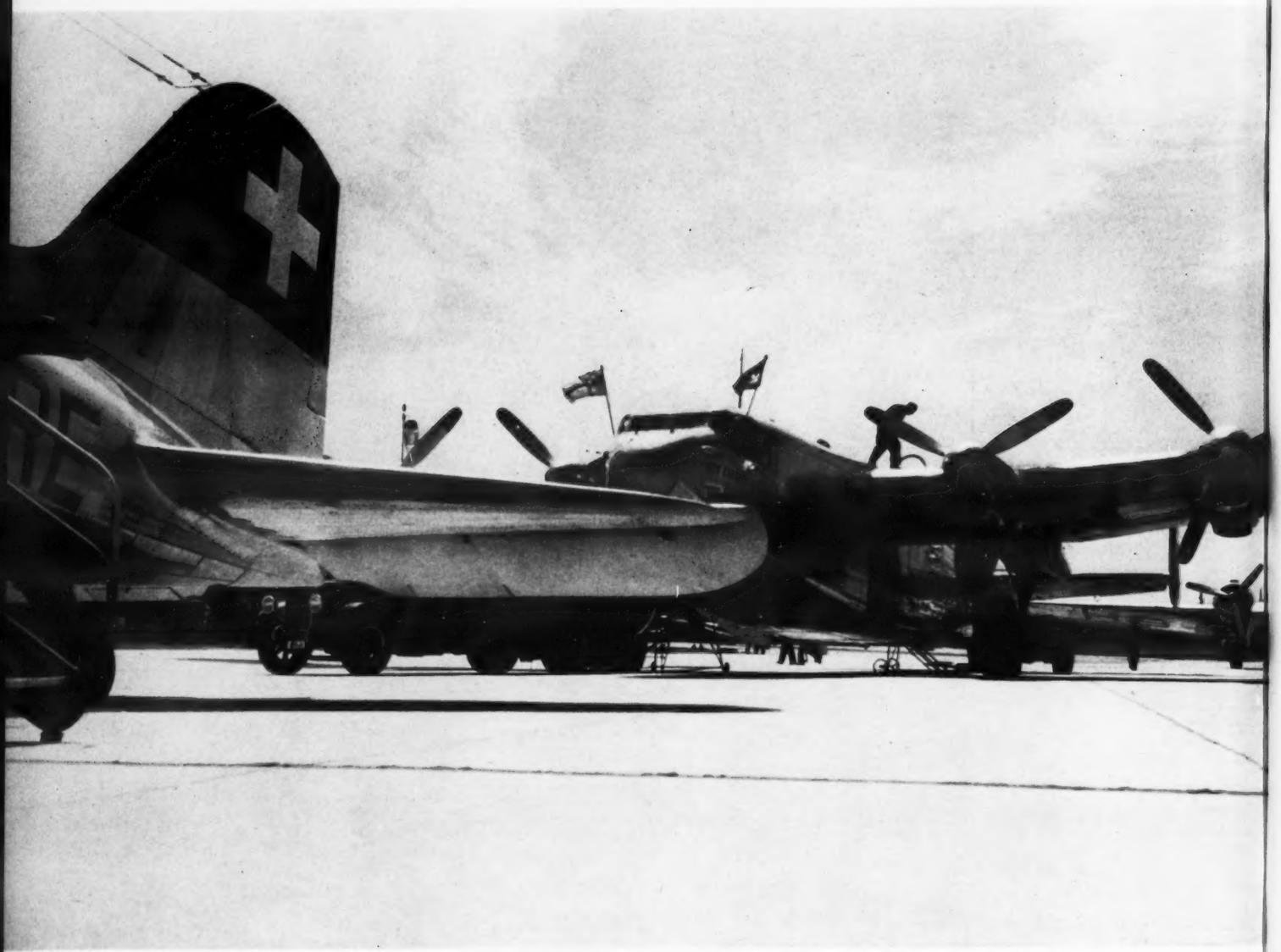

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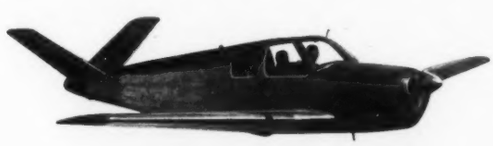

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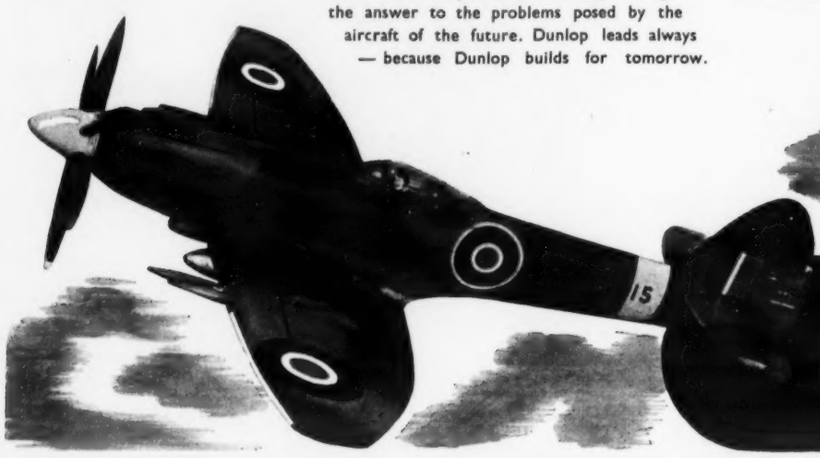

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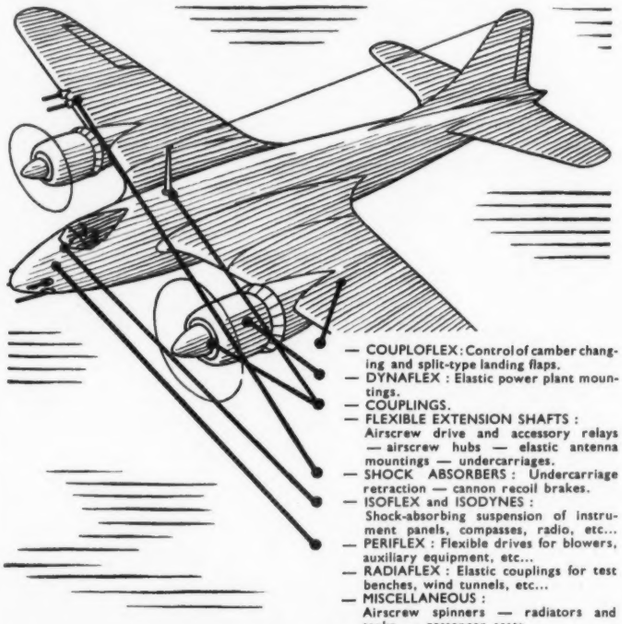

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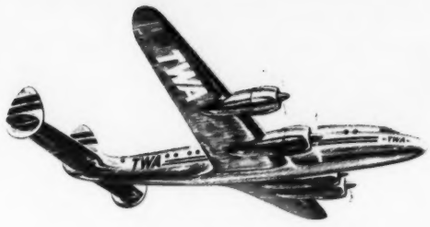

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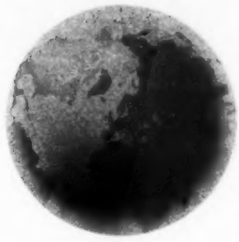


Double-Crossers

The Swiss-U.S. economics journalist, Frank Bates, whose articles are invariably characterised by an element of liveliness and general comprehensibility, contrasting with certain sterile theories of many political economists, recently brought the following considerations to light : With European confusion at its peak, warnings are coming from government benches in England and France against the constantly increasing activity of "spivs" and "margoulins". This is probably the first instance in European parliamentary history of the last hundred years that official attention has been paid to the existence of crooks and racketeers. It is a sign of our times : Parasites are growing rankly, taking the upper hand and wreaking havoc amidst national and international economic life.

What applies to big things also applies to small. It will be plain to everyone that all this must be even more prevalent in the youngest branch of commerce—aviation.

Was it not alleged that an eminent personality in a German-occupied country had been collaborating for a long time with the enemy ? And it so happened that this man had spent over a year in Nazi dungeons, suffered the loss of close members of his family, and lived in constant danger of his life. Ought we to remain silent about the fact that, a relatively short time ago, an attempt was made in altogether too interested circles to ruin with similar accusations the reputation of a highly-respected promotor of aviation in a neutral country, when all the time this man's sympathies and connections clearly pointed to the West ?

Does it not strike one as too comical for words that an absolute nobody, who a few years ago wrote a toadyish book entited "Mussolini, the Aviator," today wants to play the saviour of his country ?

Some may recall the case last August of the alleged attempt on the part of criminal lunatics and undesirable aliens to overpower their guards in an aircraft flying them over from the U. S. A., and the subsequent effort by the charter carrier involved to boost this story, filling the press with sensational reports aimed solely at gaining itself prominence.

Is it right to accuse the U. S. magazine "Fortune," one of the world's most valuable publications both from the standpoint of contents and make-up, of sabotaging aviation ? And this merely because the editor clearly and firmly explained that there existed certain misunderstandings in aviation which ought to be clarified ?

These are just a few small samples.

The case becomes more alarming when we observe the machinations to which the competition between members of the aircraft industry, or certain airline operators, is prepared to stoop.

It so happens that an aircraft is no longer simply demonstrated and offered for sale. Nowadays it is, figuratively speaking, stifled in the very womb. Scarcely is it near to completion, scarcely has it accomplished its initial test hop, scarcely have the manufacturers begun to cure its teething troubles, before people have attributed to it almost every bad flying and performance quality that a aircraft can possibly possess. If one attacks the sources of those rumours, the instigators promptly and smilingly issue a denial, the levity of which, however, is outdone by its transparence.

And the aircraft salesman is still worse. If there is no alternative, he will work beneath the surface. Not only is the aircratt sold but, between whiles, the salesman also. And this happens in firms which have an international reputation at stake.

What are the consequences facing the customer, the airline operator ? The managing directors, technical directors and leading engineers of an airline company have good reason to be torn between doubts. They really do not know whom to believe. On the one hand they have to renew their flying equipment, on the other they cannot make out whether they are not falling into a trap. They do not only have to shoulder the responsibility for passengers' safety, but they also have to safeguard the interests of their company ; and present-day investments in airline equipment are so high that the slightest error of judgment can easily bring a firm to the verge of bankruptcy. But if a man has the courage, after weighing the pros and cons, to buy an aircraft type, then it can happen that the beaten competitor accuses him of having certain material interests in the deal, or, to express it more plainly, of having been bribed. Such things may sound improbable, but are authentic. And nothing can be gained by passing over them in silence. This unfortunate state of affairs would otherwise only prevail. Blackballing, blackmailing . . .

If such practices have been introduced in the higher spheres of aviation, then it is not hard to imagine what goes on elsewhere. There are less important spheres. To these belong, among others, the great number of aviation journalists who, during and after the war, discovered their so-called profession and are today willing to serve the cause of these nefarious machinations. Blackmail from top to bottom . . .

Who, then, of the earlier leading aviation journalists is still active in the branch ? Merely a few, whose number can be counted on the fingers of one hand.

Dr. Edward P. Warner, who originally endowed the U. S. aeronautical magazine "Aviation" with its world-wide reputation, is today in Montreal, shaping the destiny of the International Civil Aviation Organisation. His successor as editor of "Aviation," Captain Paul Johnston, at present heads the famed Institute of the Aeronautical Sciences. Cy Caldwell, who for many years was leader writer on the staff of "Aero Digest" and wielded perhaps the sharpest and most spirited pen in the branch, has turned his back on aviation. C. C. Grey, the grandfather of British aviation journalism, whose personality was stamped on the aeronautical weekly "The Aeroplane," is now leading a contemplative family life, as befits his years. Henri Bouché, whose magazine "L'Aéronautique" embodied the best in French aviation

literature, today heads his country's delegation to ICAO in Montreal. There is nothing we can say about German or Italian trade literature ; of Russia, we know less than nothing ; the majority of other publications do no harm, but do little good — and then comes the mass of new disciples.

Let us continue by considering the international bodies and organisations connected with aviation — UNO, ICAO, IATA ; we are sadly forced to observe that their existence is not owing to the qualities of the separate delegations, but because they are led by persons with a reputation for fairness, honesty, and straightforwardness — be their names Warner, Roper or Hildred.

The world has become poor, and poverty is not infrequently accompanied by corruption. It is therefore understandable that warnings against "spivs" and "margoulins" are emanating from the government benches in Great Britain and France. In aviation, which has still to find its fulfillment and whose pastures must first be drained, bog-weeds find a particularly fertile soil.

Is it the road to ruin ? Not at all : it is only a crooked lane, a thorny path, and certainly not the path of progress.

We are not alone with our fears and uneasiness. During recent months we have observed that, in international bodies such as ICAO and IATA, as in individual airline companies, earnest steps are really being taken to introduce new and better measures to enlighten the public, improve relations with the industry and press. And, as was reported in last month's issue of this magazine, the men of international aviation responsible for this particular field, the Public Relations Officers, recently met together at a IATA conference in Prague.

This was a small beginning, which, quite incidentally, resulted in the Public Relations Officers of sixteen international airlines, some of whom had never known each other before, some very slightly, suddenly calling one another by their Christian names. This was, moreover, a small beginning, because for the first time a distinct endeavour was being made to eliminate injurious competition between the participant companies and to give the public an impression of better friendly collaboration. Finally, it was a small beginning because the majority of people at the Prague conference gave the impression of being decent men who knew their jobs. "Spivs," "margoulins," or racketeers would have found Prague very boring and a complete waste of time, for there was nothing material to be gained, and nothing to be derived even from indiscretion, not to speak of blackmail.

It is our opinion that this small beginning towards a cooperative effort in aviation, which was to be observed in Prague, should be pursued on a considerably grander scale. Aviation, as a branch of economic life, is assuming proportions which call for an exemplary code of honour in competitive efforts.

Have you ever heard of such a thing as a great New York bank launching rumours or accusations designed to rob a competitor of business ? Can you possibly imagine such an occurrence among big English or French banks ? Are the great international shipping companies in the habit of spreading untruthful stories about one another ? Has a great shipbuilding concern ever been known to refer to a new construction of a competitive firm as an unseaworthy crate, saying that it is obsolete, uneconomic, or dangerous to sail on ? — There is no reason why competition in aviation should not also be placed on cleaner foundations.

What ought to be done about it, then ?

We would like to assume that the moment had come for international civil aviation in its entirety, on a representative basis, to enter the public limelight, to explain its achievements and aims clearly, and in this manner to gain the public's confidence. This alone would suffice to frighten off corrupt outsiders.

In principle, the basis for such a demonstration exists, in the very fact that we have international organisations like UNO, ICAO and IATA. The possibilities are surely manifold ; and why one possibility is mentioned here is because it so happens that it was first recommended in 1935 by the publisher of this magazine, and put forward again in Prague last July. The following was proposed :

> *". . . Airline operators and aviation insurers should have the greatest interest in the elimination of all avoidable hazards in air transportation. On the other hand, of all international civil aviation commissions and organisations, the International Air Transport Association, which was reborn in Havanna in spring, 1945, and which now includes about sixty major airline companies, has produced the greatest number of practical results.*
>
> *Would it not be possible for this Association to present itself every year to the world's public in a prominent manner ? It could do this by creating an annual* I. A. T. A. Grand Prize, *to be awarded for the best practical — not theoretical — work done to further civil aviation during the year. Would not a kind of* Nobel Prize of Aviation *be the most appropriate propaganda for air transportation, for the growing safety of the air services ?*
>
> *It ought to be possible for the airline companies, jointly with the great insurance firms, industrial and petroleum concerns, and collaborating with the major aeronautical research institutes, annually to establish a well-defined programme of improvements required to increase the safety of the air services. Such a group should be in a position to finance a number of big money awards every year in order to incite scientists and engineers to place themselves at the service of our cause and get to work on this safety programme.*
>
> *It seems unnecessary to describe in detail the advantages such an I. A. T. A. Award would produce from the engineering, industrial, cultural and propaganda points of view . . ."*

Let us think back. What did the world know, some seventy years ago, of the Nobel Prize for science ? In a few years, perhaps, the idea of a IATA Aviation Prize — or whatever one may choose to call it — may be just as familiar to the public as the prize founded by the inventor of dynamite. In such a prize we must be careful to embody those ideals which, today, humanity so easily forgets, but without which it cannot hope to progress.

We began with observations and criticisms which are probably dormant in the minds of numerous people engaged in the field of aviation.

Furthermore, we made a practical suggestion for replacing bad with better and combatting the evil elements in competition.

In our desires and efforts, we do not feel alone. The man from Texas and the man from California, the man of aviation in the far North, in the West, South, and even in Eastern Europe, are all thinking along similar lines, perhaps thinking exactly the same as we are. With all these friends to back us up, we feel ourselves strong.

And as aviation is still a young formation and perhaps, in many respects, still an affair of the pioneer, it might not be too bad an idea if the customs and practices of the old pioneers of the American Northwest were also applied.

You may recall Jack London's descriptions of the Klondyke : how those pioneers used to nail the hand of the cardsharper to the table with their hunting knives.

Perhaps those old American habits were not exactly gentle ; but they were effective. And, in order to introduce cleaner elements into aviation — if there is no alternative — we must simply return to the old pioneering customs.

EEH

Belgian Commercial Aviation

Sabena

BY GUS PONCIN, BRUSSELS

In reality, Belgian civil aviation took its genesis before the end of World War I.

Whilst the cannon roared on the Yser, Georges Nélis, a Belgian Air Corps lieutenant, used to spend his nights on duty in a hut near the airfield, studying the possibilities of applying the aeroplane to future peace-time.

He confided his ideas to Tony Orta, another Air Corps lieutenant, who had piloted seaplanes during the Tanganyika campaign. These two officers discussed projects which combined both daring and common sense. And it was not long before an air transportation system for Belgium and the Congo was born, on paper only, of course, but based on figures and statistics.

In 1919, three and a half months after the Armistice had been signed, Georges Nélis discarded his uniform and founded, with the support of King Albert, the " Syndicat National pour l'Etude des Transports Aériens " (national syndicate for studying air traffic problems), popularly known as SNETA.

A short while after, a parallel organisation was set up, the " Comité d'Etudes pour la Navigation Aérienne au Congo, " or CENAC, which was subsidised by the " Roi Aviateur " with special funds left to him by King Leopold II for his African studies.

From its base in Brussels, the " Syndicat d'Etude, " which was soon registered as a company, flew military aircraft with their armament removed, to Paris, London and Amsterdam. These aircraft, whose cockades and black-crosses were still dimly visible through the new paint, flew a 668-mile network, the nucleus network of Belgian air transport. It was in 1920.

The " Comité d Etudes " began by photographing the Congo region from the air to complete its information on the cartographical and hydrographical features of the country. It commissioned SNETA to run a seaplane service from Leopoldville to Stanleyville, on an experimental basis, following the course of the river. But the flying equipment chosen, three-seater Lévy-Lepen aircraft acquired from the French Navy, was not at all suited to African conditions. The effect of the water and the sun quickly loosened the plywood panels of the hull, and after each flight the wooden portions of the structure had to be secured again. Besides this, the engines functioned extremely badly, and breakdowns were altogether too frequent. But in face of all these setbacks, there was no lagging ; and at the beginning of 1920 the first leg of the regular line was in operation between Leopoldville and N'Gombé. Thefirst equiatorial airline had been established. In honour of its Royal patron this new colonial success, at that time unique in the world, was christened "Ligne Aérienne Roi-Albert" (LARA).

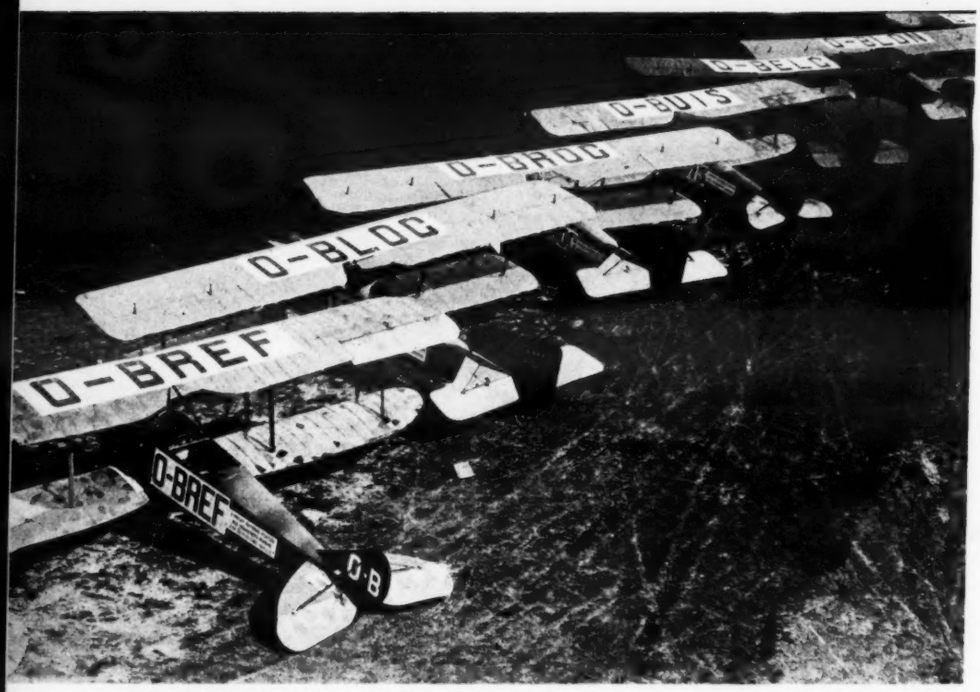
In 1922 SNETA decided to suspend its experimental activities in Europe and Africa. Far from signifying a definite cancellation, this measure, with the help of the State and of the Congo, gave birth to the Société Anonyme Belge d'Exploitation de la Navigation Aérienne, or SABENA. Belgian flying had emerged from the experimental stage. The air routes were now being flown on a commercial basis. It was the practical beginning.

Registered on May 23rd, 1923, the new company restricted its first few months of commercial operation to transporting newspapers between Brussels, Ostend and Lympne. To be on the safe side no passengers were carried. Because the route involved flying certain stretches over water and the operators could not fully rely on the capricious wartime engines, SABENA set itself a motto : " Safety First."

In the spring of 1924—in those days flying in winter was out of the question—the company sent its aircraft along a new route, which was twice as long as the road taken by the newspapers during the preceding year. It passed over Holland, Belgium, Luxembourg, France and Switzerland, linking Amsterdam and Basle by way of Rotterdam, Brussels and Strasbourg. This time, passengers were carried, too. The aircraft of 1918, still in operation, had in the meantime been carefully adapted to their new duties. Aft of the cockpit was now a closed cabin for two passengers, which gave the aircraft the appearance of a dromedary. But odd as it may have looked, this hump was symbolic of SABENA's newest ambition : to provide comfort for its passengers.

During the same year the company acquired twin-engined Handley-Page aircraft, which, though they had been designed specially for commercial flying, did not turn out to be a success. Contrary to present-day twin-engined transports, they could not fly on half-power without losing a great deal of altitude. Later on, SABENA became interested in three-engined aircraft and was the first European company to operate such types, simultan-

King Albert I, the "Roi Aviateur," was very keen on the development of Belgian civil aviation.



1920 : SNETA used converted two-seater military aircraft.

eously initiating, at the beginning of 1925, a new formula of security.

* * *

In those days a flight from Belgium to the Congo was rather a fanciful ambition. The average person was frankly scared of the long-distances over seas and deserts between intermediate stops, which, in this imagination, involved wild stretches of prairie and forest, overrun by fierce beasts of prey. Lieutenant Edmond Thieffry, a World War I ace, courageously undertook to fly the route. His crew members, Pilot Leopold Roger and Engineer Joseph De Bruycker, both in the service of SABENA, were likewise chosen for their courage. The aircraft selected was one of the three-engined types which the Belgian SABCA aircraft manufacturing concern was building for SABENA under licence to Handley-Page.

These three men took off on the morning of February 11th, 1925. The weather was cloudy and grim, but the flame of adventure burned brightly and, from every aspect, their trip was truly an adventure. It lasted 51 days. Thieffry and his companions were real explorers of the sky. They established an aerial highway 5,000 miles long, leading to a magnificent future.

A few days after they had arrived in Leopoldville, SABENA inaugurated its real service to the Congo. It had abandoned the "Ligne Roi-Albert" with its fearsome itinerary along the river. Flying in straight lines, it had to clear away large portions of jungle and forest to provide main and alternative landing stations. In April, 1925, the Leopoldville-Luebo route, the first leg of a great link which was to cross the immense Congo area, was opened to passengers. This service, 1,415 miles long and comprising six airports and 74 alternative airfields, was completed two years later, and could be flown in 2 ½ days.

In the meantime, SABENA had been progressing in Europe, too. After 1927, the aircraft were no longer confined to their hangars as soon as winter set in. SABENA crews were in the sky, in sunshine, rain or snow ; and in 1929, when the company acquired Fokker F. VII three-engined transports fitted with the earliest blind-landing equipment, night airmail services were begun.

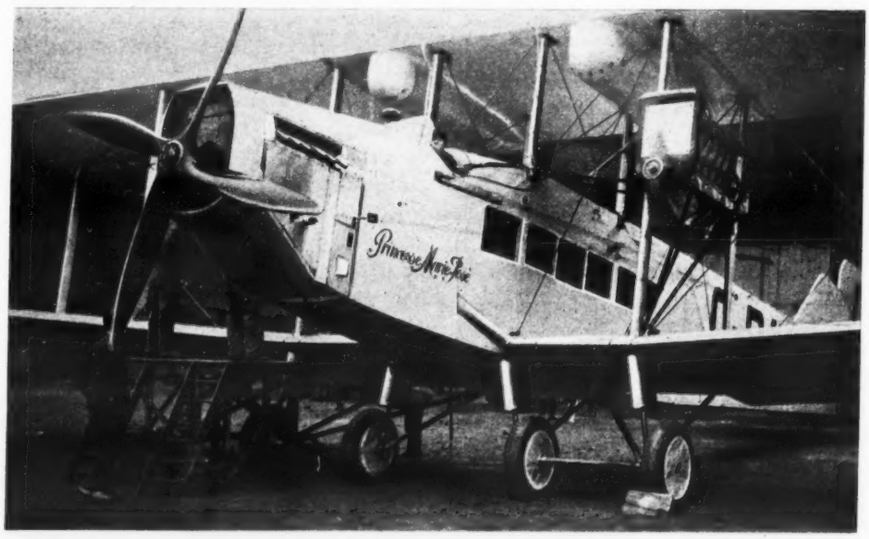
In 1930, Belgium celebrated its 100th Day of Independence, inviting the world to the exhibitions at Antwerp and Liége. On this occasion, SABENA publicised, in graphic form, its accomplishments during seven years of existence : a 2,800-mile network.

Whilst developing and expanding its separate European and African networks, SABENA was simultaneously preparing to merge these two fields of activity. In 1935 a SABENA aircraft flew, in five and a half days, the route which had been pioneered ten years beforehand by Thieffry : Brussels—Marseilles — Oran — Colomb-Béchar —Reggan — Bidon V — Gao —Niamey — Zinder —Fort Lamy—Fort Archambault—Bangui—Coquilhatville—Banningoville—Leopoldville. Subsequent to this proving flight, regular traffic between Belgium and the Congo commenced.

In the same year the company began operating Savoia-Marchetti S. 73 three-engined transports on its European routes. This was a low-wing monoplane which gave very satisfactory service. Accommodation grew from 10 to 17 passengers per aircraft ; speed rose from 100 m.p.h. to 170 m.p.h. The Belgian firm acquired a licence for building this aircraft and named it SABCA-Marchetti. In October, 1936, it was put into service on the Congo route, in which capacity it clipped the flying time from 56 to 36 hours, saving passengers two days on the journey.

In those days passenger comfort was more of an illusion than a reality. SABENA sought and found a novel solution to this problem. The company opined that, on very long journeys, speed was an element of comfort. Shortening the duration of the trip and flying the long sections of the route as quickly as possible, SABENA reflected, was the best means of eliminating the insufferable fatigue caused by prolonged immobility. In order to put this idea into practice, the company purchased new Savoia-Marchetti S. 83 three-engined transports. Although these new aircraft provided less accommodation than the SABCA-Marchetti types, they were consid-

November, 1925 : Three-engined Handley Page biplane, built in Belgium by SABCA, in which Lieutenant Thieffry made his epic flight to the Congo.



Three-seater Lévy-Lapen flying-boats were used in the Congo on the "Ligne Roi Albert."

erably faster, top speed being 280 m. p. h. and cruising speed, 225 m. p. h. They were the fastest aircraft of their day and enabled SABENA to reduce actual flying time on the Congo route from 36 to 24 hours. The company thus gained itself the " Blue Riband " for inter-continental flights.

SABENA did not remain idle. By 1939 its route network comprised 10,565 miles, extending from 60 deg. north to 12 deg. south. Its aircraft flew over seventeen countries. Its flying personnel included numerous " millionnaires of the air. " The Belgian capital was linked with Berlin, Cologne, Copenhagen, Dusseldorf, Essen/Mülheim, Frankfurt. o. M., Hambourg, Le Zoute, London, Malmö, Munich, Ostend, Paris and Vienna. As Belgium represents a geographical crossroads, this network was due to form the nucleus of European civil aviation. From Brussels or Antwerp, reciprocally linked by seven services daily, one could fly, within a day, to any one of 120 major cities.

*

The fateful event of September 3rd, 1939, caused a stoppage of all Belgian air services. SABENA's aircraft, condemned to inactivity, were confined to their hangars. Towards the end of the year, however, the company was authorised to fly a service from Brussels to Shoreham-by-Sea, in Great Britain, and one from Brussels to Amsterdam, whence the Scandinavians, who had resumed operations by then, provided a connection. Subsequently, in February, 1940, the Congo service was resumed, but with Marseilles as starting point and passengers having to travel there by train.

On May 10th, 1940, Belgium was invaded. As so often before in her history, Belgium, owing to her geographical position as a crossroads, became the European battlefield once again.

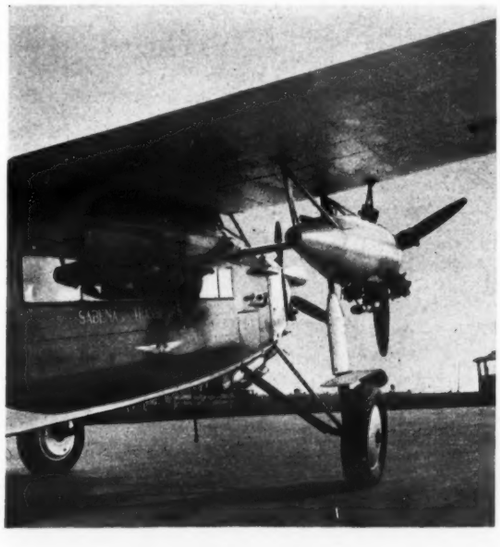
SABENA was obliged to suspend all activities during the Nazi occupation. In Africa, however, after a very few weeks of forced standstill, it resumed its old schedules. In addition to this, the company contributed towards the colonial war efforts in a measure tenfold of that which had been demanded of it.

The entire European flying equipment was kept out of the invader's reach and ultimately transferred to England, where it was able to help considerably in the war effort. Those aircraft which escaped the fire of the German fighters and flak were grouped together in North Africa and, together with the Savoia-Marchetti transports used on the Congo line, placed at the disposal of the French Air Ministry. After using them for one month, the Vichy Government unjustly handed them over to Italy.

Thus SABENA had been deprived of its most up-to-date equipment and, having no source to which it could turn for help, possessed nothing besides the equipment at its Congo bases : seven Fokker F VII and six Junkers Ju. 52 transports. Despite all this, the company managed to inaugurate the long Elizabethville—Cairo route in September, 1940. Towards the end of 1940, two Lockheed L-14 aircraft of the Régie Air Afrique were added to this small fleet, and in 1941, another two aircraft, this time Lockheed L-18" Lodestars, " were received from the Americans. In 1942, SABENA acquired two old Junkers Ju 52's, which had been stationed at Lagos, from the British. Until it received five more Lockheed " Lodestars " in 1943, these aircraft were all that the company had at its disposal. But all the time, SABENA aircraft had been flying from coast to coast of the immense black continent, from Cape Town to the Nile delta, from the Gulf of Guinea to the Red Sea. During the fighting in Tripoli and Ethiopia, in which Belgian colonial troups were participating, SABENA's aircraft were incessantly casting their shadows over the deserts and jungles, transporting officers and men, arms and ammunition, food and medical supplies. On military missions, they landed in French Equatorial Africa, Gabon, Cameroon, Algeria, Angola, Uganda, Kenya, Tanganyika, Madagascar, the Union of South Africa, Egypt, Palestine.

SABENA crews were ceaselessly crossing the skies, many covering over 30,000 miles in a month. But whereas man's enthusiasm can help him to overcome his fatigue, the

In 1927 SABENA put three-engined Fokker F. VII transports into service. These were the first aircraft to carry blind-flying equipment.



In 1935 SABENA bought Italian Savoi-Marchetti S. 73 transports, and in the following year reduced flying time to the Congo from 56 to 36 hours.

The S. 73 was succeeded by the S. 83, acquired shortly before World War I for the Congo service. The Vichy government later gave all aircraft of both types to the Italians in Tunisia.

During the war, SABENA operated Junkers Ju. 52's in the Congo, using them chiefly for military transportation.

same cannot be expected of his aeroplanes. Repairs could be effected up to a certain point, but it was inevitable that, sometimes, aeroplanes had to be sent to the scrap heap and replaced with fresh types. Tyres were worn down to the canvas, and new wheels had to be cast from melted-down airscrews. Spare parts were removed from booty captured in Ethiopia. Even the wrecks of Italian aircraft shot down over the Libyan battlefields were utilised. There was never so much as a pause for breath in the airfield workshops. Every foreigner washed on to the Congo coasts by the storm of war was immediately bundled into overalls and put to work at the benches. In this way, however, the aircraft were able to continue plying the African skies.

The 1939 network of 3,420 miles had gradually grown to 20,000 miles. During 1944, 12,000 passengers were transported, 2,500 of these over routes exceeding 3,000 miles. There was never a single accident to mar this accomplishment, and this was perhaps the crews' most glorious victory of the war.

Eight months before the end of the war in Europe, SABENA established a connection between the Congo and the Belgian Government in London, routed by way of Lagos, the Sahara, Casablanca and Lisbon. This line was abandoned two months after the liberation of Belgium.

In July, 1945, a Lockheed "Lodestar," still wearing its wartime camouflage paint, flew from Leopoldville to Brussels. It completed the thread which the aircraft taking off from the Mother Country ten years previously, had begun to weave, but made it somewhat shorter. The deviation by way of the Tchad was cut off, shortening the trip by one day.

*

In a war-devastated Belgium, SABENA was at first unable to find either tools or workshops in which to rehabilitate its damaged equipment. As a matter of fact, all that it had at its disposal for making a new start was its newly-found courage and its old experience.

Nine months after the war, SABENA received its first Douglas DC-3's from the U. S. A., enabling the company to start several international services immediately.

And when the first Lockheed "Lodestar" returned from Leopoldville to Brussels, it could find neither hangar nor repair shop.

Already during the war, SABENA had placed orders in America for new aircraft, in preparation for its peace-time resumption. Nine months after the cessation of hostilities, the first Douglas DC-3's finally arrived, but deliveries were extremely slow.

Each delivery, meanwhile, meant the renaissance of a route; and, beginning in the summer of 1946, gleaming aircraft carrying the SABENA insigniae were once more to be seen on the air routes from Brussels to Amsterdam, Copenhagen, Geneva, Lisbon, London, Luxembourg, Nice, Oslo, Paris, Prague, Stockholm and Zurich. In order to accelerate the repatriation and replacement of Belgians in the colonies, the route to the Congo has been flown with the celebrated Douglas "Skymaster" four-engined transports since February, 1946. With these giants, it has been possible to reduce the total elapsed time for the trip to 25 hours, flying time amounting to only 21 hours. Currently, after a casual or nostalgic goodbye, passengers leave Brussels during the early afternoon, immediately after lunch. They dine in Tunis, dream their way across the Sahara and, finding daylight again, make their first stop in Kano. Subsequently, there is a final hop to Leopoldville, reached just in time for tea.

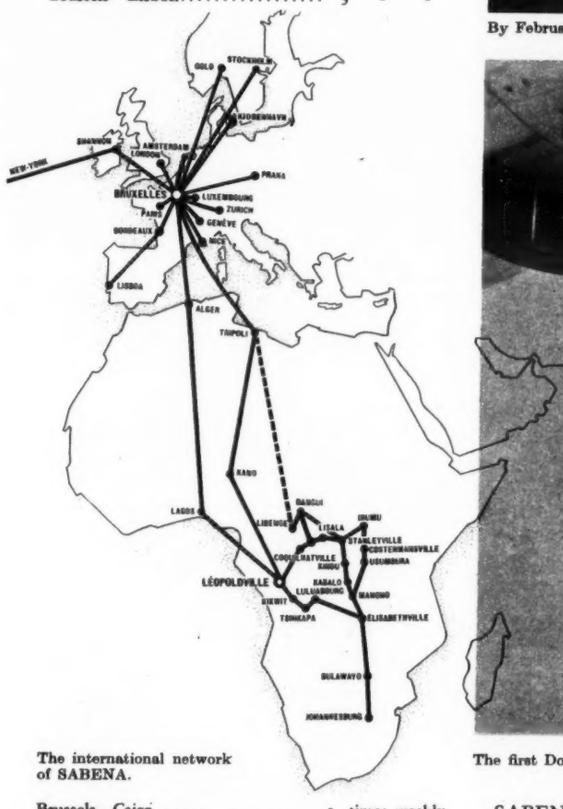
*

All of the connections broken off owing to the war have not been resumed; some of these have been dropped altogether, because of the unstable economic or political position of the countries flown to. On the other hand, however, a number of entirely new services are now to be found in the guide books. Operating statistics for 1946 show that 121,178 passengers were transported (three and a half times as many as in 1938), 96,389,061

passenger-miles flown (eight times more than in 1938) and 923,274 ton-miles of mail and freight carried (twice as much as in 1938).

Today, the routes flown by SABENA, either alone or in collaboration with other companies, are the following :

Brussels—London	7	times	daily
Brussels—Amsterdam	3	»	»
Brussels—Paris	4	»	»
Brussels—Zurich	3	»	»
Brussels—Geneva	1	»	»
Brussels—Basle	1	»	»
Brussels—Luxembourg	3	»	»
Brussels—Liége	1	»	»
Liége—Paris	2	»	»
Brussels—Knocke/Le Zoute	1	»	»
Knocke / Le Zoute—Ostend—London	2	»	»
Brussels—Ostend	1	»	»
Brussels—Deauville	1	»	»
Brussels—Nice	1	»	»
Brussels—Prague	5	»	weekly
Brussels—Copenhagen	7	»	»
Brussels—Stockholm	4	»	»
Brussels—Lisbon	3	»	»



The international network of SABENA.

Brussels—Cairo	1	times	weekly
Brussels—New York	2	»	»
Brussels—Milan	3	»	»
Brussels—Dublin	2	»	»

The Belgium-Congo route is flow daily (excepting Sundays) with DC-4's, four trips being made from Brussels to Leopoldville, one trip from Brussels to Leopoldville and one to Stanleyville, with a connection to Johannesburg, and one from Brussels to Stanleyville, passing via the Nile valley with Cairo as optional terminal.

These six flights denote 13,722 seats available annually, corresponding to half the white population of the Belgian Congo.

This intensification of the Congo service has also resulted in a strong intensification of Congo interior schedules, certain routes being flown five times weekly.

*

By February, 1946, the Congo service was being flown with Douglas DC-4 four-engined airliners.

The first Douglas DC-6 delivered to SABENA visits Geneva. These aircraft are for the Brussels—New York service.

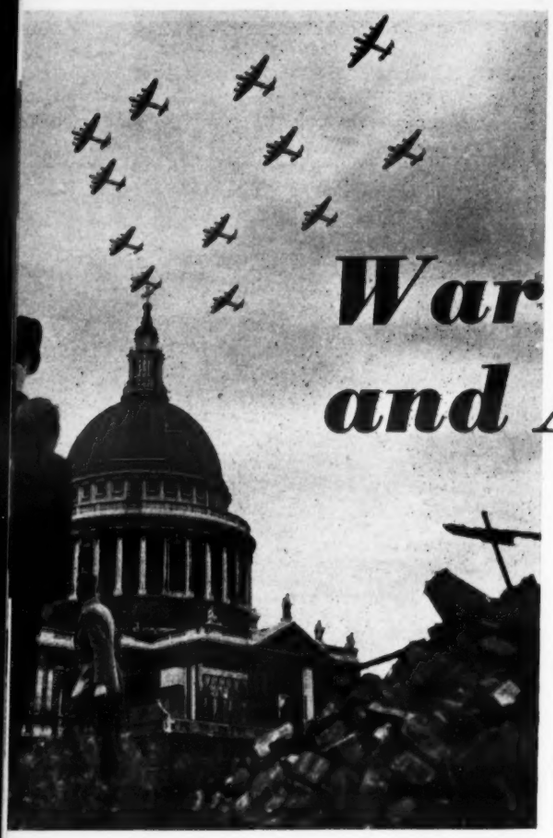
SABENA recently became the first European airline to possess a Douglas DC-6 " Superliner. " During demonstration visits to Geneva, London, Copenhagen, Paris, Amsterdam, Stockholm, Leopoldville, Johannesburg and Cape Town, this new airliner revealed a cruising speed of over 300 m. p. h., notably flying the route from Belgium to the Congo in 15 hrs. 23 min., with only 13 hrs. 25 min. spent in actual flying. Destined to fly on the Brussels—New York run, the DC-6 seats 52 passengers, or 26 in berths. Cabin pressurisation and air-conditioning guarantee passengers a high degree of comfort.

*

Builder of air routes since the days of the earliest celestial explorers, always encouraging aeronautical progress, and often contributing something itself, SABENA's advance has been at an ever increasing rate. Its deeds are worthy of comparison with those of the early Flemish seafarers.

Belgian commerce is seeking openings throughout the world. Belgian factories are working for all nations. In return, Belgium must import raw materials to keep its machines alive and the wheat which her soil cannot supply, to feed her workers. It is an eternal story of give and take. Belgians live by bartering. Her doors are open permanently to all the cardinal points.

The development of SABENA is dictated by the participation of Belgium in universal economics. If this airline company's accomplishments are significant, it is because it does not limit its activities to the narrow confines of Belgium, but plays its part in the peaceful expansion of Belgian commerce over the entire globe.



War Weariness and Air Force Budgets

	Russia	United Kingdom	USA	France	China	Sweden	Argentina
Ground Forces ...	3,800,000	1,210,000	670,000 a)	430,000	5,750,000	57,500	100,000
Combat Aircraft ..	10-16,000	*	6,500	*	540	300-700	100-200
Battleships	3	10	21	3	0	0	2
Aircraft Carriers ..	0	41	103	3	0	0	0
Cruisers	8	55	66	9-10	0	3	2
Destroyers	62-70	210	353	10-22	0	12	13
Submarines	140-210	150	186	13-29	0	25	3

* No figure available.
a) Including AAF, 1,070,000. - *Ed.*

I The Bells are Ringing — the General Staffs Planning.

By the time these words are in print, the wail of the sirens will have died down, the choirs will have ceased their chanting and the doves will have been let loose ; Buddist and Christians will have terminated their prayers with an Amen which, in this special case, is meant to signify " Never Again. " *August 6th, annual day of remembrance of the atom bomb, will already have been observed by the city authorities of Hiroshima.*

But while the Mayor of Hiroshima rings the bell placed over the spot where the bomb fell and his citizens are planting trees, symbolic of peace, in the scorched earth, hundreds and thousands of people in other cities of a world left more or less intact and sovereign, are busily compiling and examining military budgets.

Understandably, each nation endeavours to obtain information, through the medium of the United Nations secretariat, on the armament status of other nations — as though " nothing were wrong. " UNO puts through an enquiry on the current armed forces establishment of its member states and on the contingent they plan contributing towards an international police force.

According to UNO, the five great powers, and two other nations mentioned for the purpose of comparison, have the following forces at their disposal (" New York Times, " I. VII. 47.) :

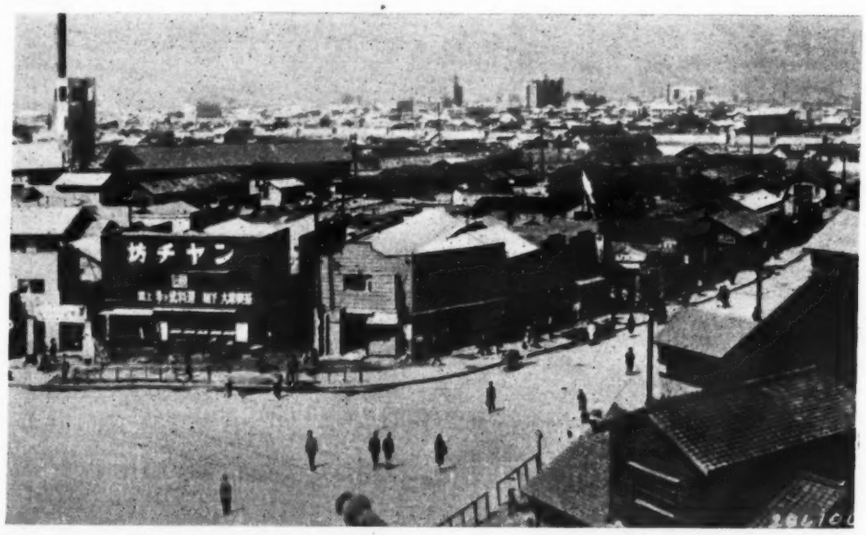
For obvious reasons, these figures cannot be taken as Bible truth. If we wish to obtain a more accurate idea in this connection, we only need to examine the military budgets of the individual powers.

We will observe two things. In general, nations and parliaments do not allow themselves to be persuaded without great difficulty that such enormous sums are nessary for immediate arming, no matter whether a conservative, liberal or socialist governement is at the helm. Despite the experience of the last war, no very great value is being attached to super-modern weapons, such as remote-controlled missiles.

The monthly magazine of the French Air Force, " Forces Aériennes Françaises, " of July, 1947, carries an article by Camille Rougeron, which is probably not published without certain intentions as this well-known military writer has invariably attacked all wrong conservative ideas in armament planning. He writes :

> " A military man who is asked to state what he needs in the way of armament will, consciously or not, establish a list of obsolete weapons with which he is familiar. What he demands of the technician is to clear from his path the menace of new inventions, which he

Hiroshima two years after the atom bomb attack.



Some French Aircraft Types now in Production

C. 800 GLIDER
Two-seater trainer.

NORD 1200 "NORECRIN"
Three-seater personal aeroplane.

BREGUET 11E HELICOPTER

MORANE-SAULNIER 472
Two-seater fighter trainer.

SUC 10 "COURLIS"
Taxi or personal aircraft.

SO 7010
Taxi or light transport aircraft.

NC 702
Eight-passenger transport aeroplane.

SO 30 R
Modern 30-passenger airliner.

LANGUEDOC 161
Four-engined 33-passenger airliner.

LATÉCOÈRE 631
72-ton flying-boat.

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The U. S. Secretary of State for War, Kenneth C. Royall, is met at Tempelhof Airport, Berlin, by General Lucius D. Clay, Military Governor, U. S. Zone.

resents because they complicate his daily work and because he cannot really understand how to substitute them for old methods — briefly, he wants the technician to prolong his youth."

General Dwight D. Eisenhower, Chief of U. S. General Staff, was probably guided by a similar thought when he recently set up his secret "Advance Study Group," consisting of three Army and Air Forces officers all between 30 and 40 years of age, whose duty is to study the probable trend of future warfare. The group is to constitute a permanent body, assisting the General, and one of the officers is to be replaced each year.

General Spaatz, Commanding-General, U. S. Army Air Forces.

II What Have the Parliaments to Say? *

The U. S. Army Air Forces plans a peacetime establishment of 70 groups and 400,000 personnel; in this figure are included 60,000 officers, of which 27,500 are to be regulars. The budget proposals presented on July 1st for the 1947/48 fiscal year ($ 5,756,791,500) envisaged $ 850,000,000 for maintenance of 55 active groups at 80 per cent full strength and 15 skeleton groups.

On May 29th the House of Representatives' Appropriations Committee approved a 3.3 per cent reduction of the sum asked for, claiming that the cut would leave "adequate funds for an army of 1,070,000 to perform the missions assigned to it." The $ 850,000,000 demanded by the AAF were shrunk to $ 733,332,508, but $ 280,000,000 requested for acquiring new aircraft and $ 27,766,400 for scientific research and developing new weapons were not reduced. General Spaatz, Commanding General of the AAF, had previously told the Committee that he required 3,000 new aircraft annually; each year 2,400 replacement aeroplanes were required as the service life of a heavy bomber was only six years at the most, light bombers, four years, and fighters, three years.

Despite General Spaatz's advice, the cuts had gone through, and it required an urgent appeal by General Eisenhower to make the Senate Appropriations' Sub-Committee restore $ 600,000,000 to the War Department budget. The AAF's request for additional credits was, however, refused by the Senate.

Thus, it may be seen that the U. S. Army had to fight for its requested credits; and the Army Air Forces, which received about 20 per cent of the total military budget appropriations, cannot be classed as an *enfant gâté* either.

U. S. Navy budget appropriations were established on July 11th at $ 4,000,000,000, by joint agreement of the House and Senate. Of this sum, $ 749,000,000 go to the Navy Air Force ($ 501,000,000 cash and $ 248,000,000 contract authority).

This is likely to be the last U. S. military budget in which the Army and Navy Air Forces make their budget requests separately. On July 9th the U. S. Senate passed a bill for the unification of the United States Armed Forces, under which all land, sea and air forces are to be placed under a single Cabinet Officer, the Secretary of National Security.

What about Europe?

The Americans have no need to envy the Europeans. The responsible officials in European war ministries are faced with tasks no easier than those of their colleagues in the Pentagon Building, Washington.

Prior to the latest *British* financial crisis, Hugh Dalton, Chancellor of the Exchequer, presenting the 1947-1948 budget in the House of Commons, had recommended an expenditure of £ 899,000,000 ($ 3,596,000,000) on defence, compared with £ 1,653,000,000 for the previous fiscal year. Of this amount, £ 388,000,000 ($ 1,552,000,000) were to be for the Army, £ 196,700,000 ($ 786,800,000) for the Navy, £ 214,000,000 ($ 856,000,000) for the Air Force, and the remainder for the Ministry of Supply. As regards the Air Force credits, these are only slightly below those of the previous year (£ 255,500,000 = $ 1,022,000,000). Moreover, the Royal Air Force receives 23.8 per cent of the total budget, which is proportionally greater than the AAF allocation.

There is also a large increase in the RAF vote as compared with the figures of the prewar years. In 1935, the RAF received 31 million pounds, 56 million in 1936, 88 million in 1937, 134 million in 1938; and only during the first year of the war, 1939, did the figure rise to 220 million.

It must all the same not be forgotten that the value of the pound has since sunk considerably and that the Royal Air Force, which lays claim to a substantial part of the entire military credits, cannot afford to be nearly as extravagant as the Air Forces of the U. S. Army and Navy. Releases and discharges in the RAF have been proceeding at a higher rate than was originally intended. Last March plans were announced for reducing the then existant establishment of 760,000 to 370,000 by the end of March, 1948. Today?

On July 29th the Secretary of State for War, F. J. Bellenger, stated in the House of Commons that the strength of the British armed forces on June 30th, 1947, was 1,301,300 men and women. The total strength of the RAF was 307,000 (284,500 men and 22,500 women), 86,640 of whom were on regular engagements.

The heaviest task currently facing the British Air Council is to preserve the structure and continuity of the RAF whilst guiding it through the storms.

Viewed from another angle, it would be entirely wrong to fix our views solely on the RAF and its present financial difficulties. We must not forget that, behind the air force of the Mother Country, are the air forces and, to some extent, astonishingly little-used financial resources of the Dominions.

The *French Air Force* is at present having to support the same restrictions which apply to the French armed forces in their entirety. Until the problem of defence reorganisation has been finally clarified, defence budgets will be presented to Parliament every quarter year. Besides this, the French economic crisis has also necessitated budget cuts.

It is obvious that figures established in this manner can scarcely give us a true idea of the actual position. Besides having to extricate ourselves from quarterly budget figures, we would have to cope with such items as "ordinary," "extraordinary," and "supplementary" credits, which all help to render the overall picture even less clear.

For the second quarter of 1947 the National Assembly approved a military budget totalling Frs. 75,722,142,000 ($ 643,638,200), included in which is Frs. 6,500,000,000 ($ 55,250,000) for the Air Force.

On August 6th the Air Minister, André Maroselli, gave grounds for allocating further credits. The French Air Force, he declared, was equipped entirely with foreign aircraft; but it was nevertheless hoped that sufficient French aircraft would be available by 1951. Until that time, however, it would be neces-

* To simplify comparison, all amounts are given in dollars. Conversion is at the following rate:
£1 = $4.00 Belg.Fr. 100 = $2.50 Fr.Fr. 100 = $0.85
Swd.Kr. 100 = $27.10.

sary to import flying equipment. He stated, moreover, that more than 90 per cent of the ground equipment had been destroyed, which meant that the majority of the aircraft had to be parked out of doors and were deteriorating at an alarming rate. If further allocations were not forthcoming, serious setbacks were inevitable.

Despite this urgent appeal by the Air Minister, who, incidentally, is planning to discharge twelve to fifteen thousand aircraft factory workers, the budget was strongly reduced and permission to buy foreign equipment was refused. The Air Force was allocated Frs. 21,000,000,000 ($ 178,500,000) in cash and Frs. 29,000,000,000 ($ 246,500,000) for buying new equipment. The Navy is to receive a light aircraft carrier of 17,000 tons, which is expected to be in service by 1951 and will be equipped for jet aeroplane operations.

The situation of the French Air Force is by no means encouraging ; and General L.-M. Chassin points out that, of all the air forces,

General Helge Jung, C.-in-C., Swedish Armed Forces.

the French has the smallest establishment in relation to the army. He adds :

> " Such a distribution of our armed forces has given rise to certain remarks in the press to the effect that we shall always be lagging and that our general staffs are assiduously preparing for the war of 1870. " *(Forces Aériennes Françaises,* 1947, No. 6, P. 743.)

The situation of the *Belgian Air Force* is hardly better than that of the French, despite

Lieutnant-General Bengt Nordenskjöld, C.-in-C. of the Swedish Air Force.

the fact that Belgium's financial position is superior to that of many of the other nations who participated in the war.

The Belgian military budget proposal for 1947/48 foresaw current expenses amounting to Frs. 166,061,000 ($ 38,194,030) for the Air Force, which is only 12 per cent of the total military budget. Frs. 278,235,000 ($ 63,994,050) were suggested for maintenance and renewal of Air Force equipment, thus about 20 per cent of the corresponding budget item for the Army.

In conclusion, a few words on the Air Force budget of a country whose air space is of extreme strategic importance from the standpoint of aerial warfare : *Sweden.* In the event of a conflict between the great powers, Sweden, lying between two fires, would be subjected to great diplomatic pressure and might even be an invasion point. The Swedish Air Force would, for a long time, be thrown upon its own resources.

Earlier this year, General Helge Jung, Commander-in-Chief of all Swedish Armed Forces, handed his recommendations to the special committtee appointed by the Defence Minister for working out a National Defence Programme. Compared with the budget proposals for last year, those of 1947/48 have been reduced by Kr. 100,000,000 to Kr. 798,000,000 ($ 168,378,000). For 1948/49, General Jung demands a defence budget amounting to at least Kr. 906,000,000 ($ 191,166,000), of which the Air Force would receive Kr. 271,000,000 ($ 57,181,000).

In this case, the Air Force allocation would be extremely high, 32 per cent of the total military budget appropriation.

III Where's the money going?

This review of air force budgets must necessarily remain incomplete. We have purposely not attempted to analyse the Soviet Russian budget figures, insofar as such have been released. In order to understand such figures, it is indispensable to know something of the debates which led to their establishment. The contents of debates of this nature, the proposals, counter-proposals, and criticisms, are not made known to the public in Russia. A budget without commentary may be compared to a railway guide which merely states the times of arrival and departure and omits to list the names of the stations.

There can be no doubt that Russia is earnestly fostering its air armament. Admiral P. F. Lee, who is in charge of U. S. Navy Research, declared in a report to the House of Representatives' Appropriations Committee that there was every sign of a lively Russian interest in military research. The 1946 budget had allocated 943 million dollars for the development of new war equipment, and the 1947 budget, 1,226 million dollars for this purpose. It might be supposed, however, that other allocations, e. g. for education or for scientific work, might involve certain tems which were in the interest of armament.

On August 3rd, 1947, the Soviet Union celebrated "Aviation Day." The Russian Press reported that the Air Force had developed seven different types of jet aircraft during the past two years. Adressing staff officers of the Air Force, Marshal Wershinin, C.-in-C. of the Air Force, maintained that, in many respects, the Soviet Union was ahead of the Western Powers in the field of aeronautical science. He added that the Air Force was idolised by the Soviet people, and that the latter would spare no pains and shun no sacrifices to raise their Air Force to the highest possible level. The General described the Russians as being a "nation of flyers."

If our memory does not fail us, the expression "nation of flyers" was already used to describe another nation and was pronounced by another orator.

* * *

Whenever experts issue warnings against neglecting the air force, they usually bring the problem of production to the fore. Quite rightly, they state that the peace-time industry must be kept on a level which will allow for an immediate and tremendous serial production at all times.

Incidentally, we must not confine our thoughts to the combat aircraft (fighters, bombers and reconnaissance aircraft), but we must also think of the transport units to assure a high degree of mobility for transportation and supply.

The Chairman of the Board of American Airlines, Cyrus R. Smith, recently delivered an address in which he pointed out that the U. S. A. began the war with less than 100 military transports and ended the war with more than 10,000. At the same time he warns that, in the event of a future conflict, there would not be time again for America to prepare after she had been attacked. He quotes General Eisenhower as having said :

> "The decision in the future conflicts will be determined by our ability to act and react in the first sixty days, rather than in the twelfth, eighteenth, or twenty-fourth month, as in past wars."

Smith suggests that the State supply the airline operators with suitable financial means for maintaining a transport reserve in the event of war, which, in the case of the U. S. A., should comprise about 5,000 transport aeroplanes.

Meanwhile, keeping the industrial potential on a high level and maintaining an adequate transport fleet is not everything. An early expansion of airfields is just as important, because both military and civil aircraft are continually increasing in weight and, consequently, requiring continually stronger and larger runways. These difficulties are piling up at such an alarming rate that a suggestion has already been made that military aircraft be catapulted at take-off and mechanically arrested when landing, as in the case of aircraft carriers operations (General Chassin in "Forces Aériennes Françaises," July, 1947, P. 481.

In all countries, military aviation calls for extremely expensive preparations. Measured alongside these tasks, present air force budgets manage to appear quite modest. *He.*

The Helicopter

PROMISE AND CONTRADICTION

BY DEVON FRANCIS, NEW YORK

The other day a U. S. citizen of considerable financial means telephoned a U. S. commercial operator of helicopters to ask : "Can I hire one of your machines, with a pilot, for the weekend ?"

"Certainly," the operator responded.

"What will it cost ?"

"Where do you want to go ?" countered the operator.

"From New York City to my summer home in upper New York State."

The operator sparred for time. He asked how far it was, whether additional flying in that vicinity would be expected, just when the helicopter and its pilot would be released. While he sparred, he made a fast estimate of his costs and the profit. Finally, he said :

"That will be six hundred dollars."

The owner of the helicopter will never know whether his prospective customer fainted. The telephone connection was broken off. He didn't get the contract.

The incident serves to point up a fact which is being blithely ignored in the universal talk about the utility of the helicopter : the machine is notoriously inefficient as a weight-carrier. It is expensive to run. It is hard to fly, and because of that, it requires an expensively-trained pilot at its controls. Helicopter schools charge from $ 1,500 to more than $ 2,000 for their pilots' courses. As compared with conventional aircraft, it is temperamental — its maintenance is costly and meticulous. Speed-wise, it is terribly slow. Mechanically, it is an engineer's nightmare.

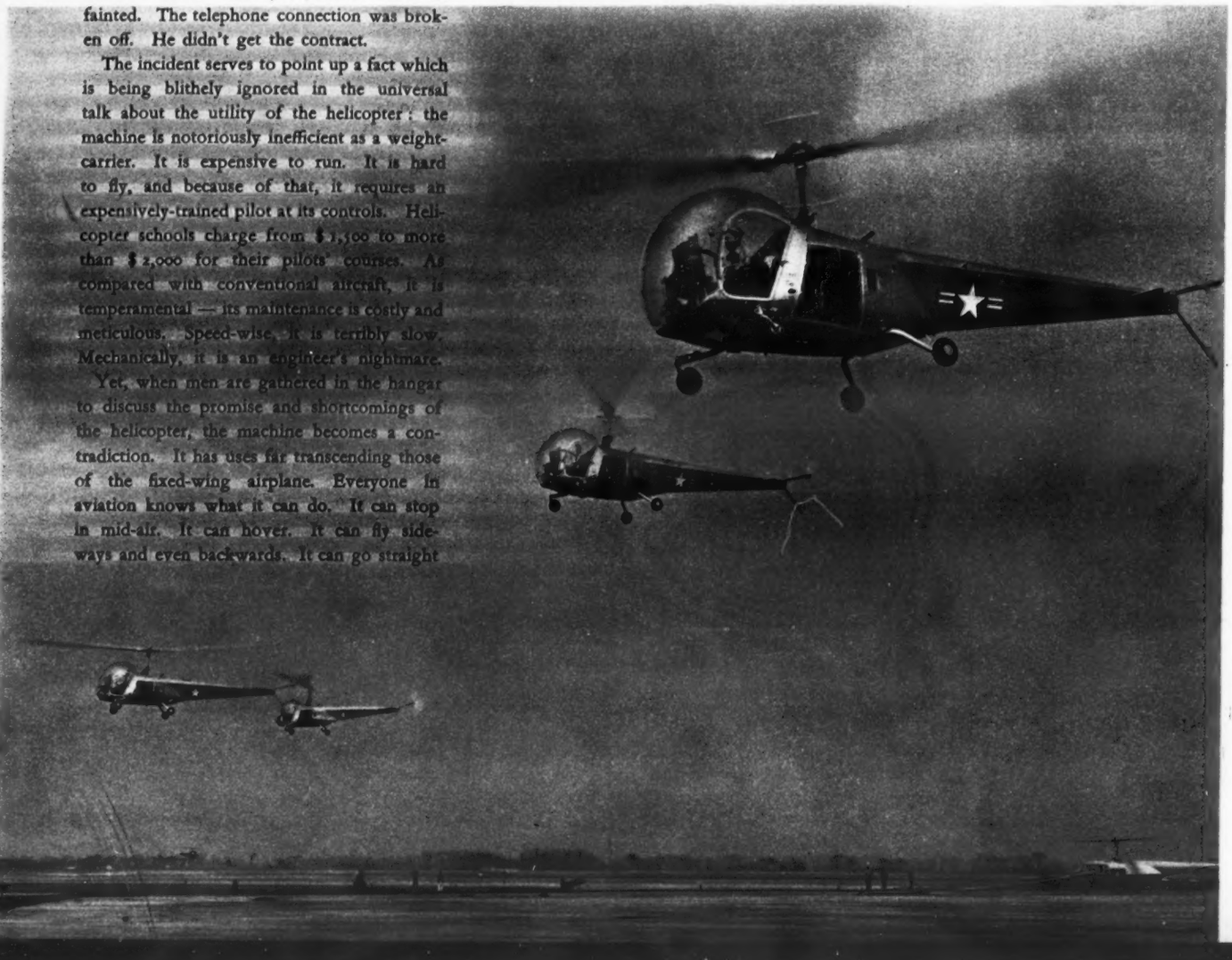
Yet, when men are gathered in the hangar to discuss the promise and shortcomings of the helicopter, the machine becomes a contradiction. It has uses far transcending those of the fixed-wing airplane. Everyone in aviation knows what it can do. It can stop in mid-air. It can hover. It can fly sideways and even backwards. It can go straight up and straight down. It can fly at a forward speed of one mile an hour or upwards of 100 miles an hour.

And therein lies the contradiction : economically it is a horrible contraption for persons accustomed to think in terms of money-return on airplane investment. But where is to be drawn the line between aircraft investment and money-return with a vehicle which, day by day, is exhibiting new usefulness in fields of commerce only lightly tapped to this moment or, indeed, never before explored ? The helicopter delights its proponents, confounds its critics.

How can anybody evaluate the helicopter ? Let's reduce the problem to an absurdity and proceed from there. An automobile deposited in the lush jungles of the island of Guadalcanal, focal point of the United Nation drive against the Japanese more than five years ago, was only an oddity. Until a road was built to accommodate its wheels, it was useless. Today the helicopter as a transportation vehicle is utterly lost in a welter of world airports. It is in a medium foreign to its temperament. To use a colloquial American expression, as compared with an airplane the helicopter is a horse of a different colour. *Comparison* of the helicopter with the airplane is impossible, especially on a cost basis. It is a matter of *contrast,* not comparison, and not on a basis of cost but on a basis of what each machine will do.

First, let us look at the helicopter and its extravagances purely on a cost basis.

Sikorsky Aircraft, a division of the United



Bubble-canopy Bell 47-model for exploration work.

Aircraft Corp., at Bridgeport, Connecticut, figures the direct and contiguous operating costs (exclusive of operating company overhead) of its S-51 helicopter, seating a pilot and three passengers, at $ 49.26 per hour — or, at an average speed of 75 miles an hour, 66 cents a mile. Sikorsky's figures are pertinent because it is one of the two companies in the United States actually turning out helicopters (in limited volume) for commercial sale. This is the way Sikorsky breaks down that $ 49.26 :

Fuel and oil	$ 5.94
Maintenance and service	5.10
Depreciation	15.92
Replacement parts, overhauls	8.75
Pilots' costs	7.20
Insurance	5.75
Hangar rental	0.60

The importance of figures derives only from the interpretation placed on them and the variety of premises from which they are drawn. Just what does that $ 49.26 mean ?

It means, first of all, a cost estimate for each of five helicopters owned by a commercial operator who flies each of them an average of 1,000 hours a year. On a hypothetical estimate of 375,000 miles (at a mean speed of 75 m.p.h.) for the five machines, the fuel and oil costs are figured at 30 gallons of petrol an hour, costing 18 U. S. cents per gallon for 91 octane, and 54 cents for oil. Sikorsky points out that on long flights under cruising conditions fuel consumption reduces to 28 gallons of fuel an hour.

As for maintenace, I quote from Sikorsky : "Present indications are that, in order to maintain five helicopters to a utilisation of 1,000 flying hours per year each, it will be necessary to have three specially-trained helicopter mechanics and three helpers. These should be able to keep four out of five aircraft in flying condition for an average of five hours' flying per day each.

A mechanic's salary is estimated at $ 3,500 per year, and a helper's at $ 2,500 per year, making a total of $ 18,000 per year for the maintenance crew. An additional $ 7,500 is estimated for miscellaneous supplies and small parts. Thus the cost of maintenance and service per hour might be : ($ 18,000 plus $ 7,500) divided by 5,000 hours per year, equals $ 5.10 per hour."

These figures are typical and probably conservative so far as direct costs of helicopter operation are concerned. Actual costs may run lower. It is interesting, however, to pursue the Sikorsky breakdown :

Depreciation is based on a four-year period to 15 % of the original price of $ 75,000. The residual value would be realised from spare parts. Sikorsky anticipates replacement parts to be three sets of main-rotor blades, three sets of tail-rotor blades, three sets of main-rotor-blade dampers and five sets of clutch shoes. These items may cost close to $ 20,000. Added to that would be other

XR-1 U. S. Army machine with laterally-disposed rotors.

Conventional Bell 47 cabin model.

Purely experimental Bendix coaxial model.

Bell 47 on floats.

Two-place Sikorsky 52 model, companion to older S-51.

replacement parts and overhauls of the engine and transmission parts, and an item of $ 5,000 is included for anything else. Pilots' costs are estimated on a basis of 800 to 900 flying hours a year and an average salary of $ 6,000. Insurance is figured at a base rate of 7 % a year for crashes on the 1,000-hour-use estimate ; passenger and public liability and property damage at 50 cents an hour.

Insurance costs as a part of direct operating expenditures are important. Ask any operator.

Other figures can be had for the asking : E. Burke Wilford, a pioneer in rotary wing research in the U. S., estimates that it will require a 20-passenger helicopter to make short-haul helicopter service feasible. He presents this table :

	DC-3	10-Pgr. Helicop.	20-Pgr. Helicop.
Hourly cost with 100% overhead ..	$ 124.00	$ 79.00	$ 117.00
Station-to-station speed	150 m.p.h.	100 m.p.h.	110 m.p.h.
Cost of operating vehicle per mile .	$ 0.83	$ 0.79	$ 1.06
Cost/passenger mile, 70 % load factor.....	$ 0.045	$ 0.10	$ 0.06

These figures, too, are subject to juggling. The hourly costs of operating 10- and 20-passenger helicopters are only estimates. Except for experimental military models, no large helicopters are in the air. Wilford's station-to-station speed for either of his hypothetical helicopters is probably high. His appended statement that an overhead of only 50 % for the 20-passenger helicopter would reduce the cost per passenger-mile to $ 0.045 is, of course, pure conjecture. Yet who is to say that he is wrong ? He points out with logic that the Civil Aeronautics Board, an agency of the

Two Sikorsky models contrasted.

American government charged with the regulation of air traffic, is entertaining applications which estimate costs for 8-passenger helicopters as low as $ 0.06 a mile.

Wilford also makes a highly pregnant remark in the course of a study he has prepared : "Present day costs show that the initial costs of the machine (a helicopter) is too high per passenger seat, being $ 25,000, while the DC-3 is $ 7,500. The depreciation over three years is too short a time, and the maintenance cost is still based upon too little experience. *These present day costs may decrease sharply under post office subsidised operations.*"

The plain fact is that air passengers are expensive cargo, whether they ride in fixed-wing or rotary-wing aircraft, and that higher-density cargo may ultimately be the key to economical helicopter operation in scheduled air transportation. Mail, naturally, is a high-density cargo. Despite a figure of approximately $ 50 an hour as the cost of operating a Sikorsky S-51 helicopter, the U. S. Post Office Department estimates that airmail operations are well within the economics of a 5-cents-an-ounce rate. That it the rate which applies to fixed-wing transport contracts. The Department's analysis is based on tests run in Los Angeles in July, 1946, and in Chicago last autumn for the carriage of mail. Army-Sikorsky R-5 helicopters (comparable to the S-51) were used.

In the Los Angeles tests with the R-5's, a total of more than 8,000 miles were flown, including 800 scheduled landings and take-offs. The machines flew through heavy rains, high winds, and visibilities as low as a quarter of a mile. It is a point of particular note that the overall average for schedules maintained both in Los Angeles and Chicago was better than 98 %. Helicopter Air Transport, of Camden, New Jersey, whose principal executive officer is Norman Edgar, a Britisher, told me that he estimated the hourly cost on his four-place Sikorsky at $ 70. Yet, in the next breath, he said he was ready to bid on airmail routes at a rate which would net him $ 60 an hour.

"But that would be unprofitable, would it not ?" I asked.

He only smiled in return. Evidently there is more to helicopter economics than meets the eye.

Wilford is the real optimist in the business : "The fare obtainable with a 20-passenger helicopter will not exceed 5 cents per passenger-mile . . . In order to benefit the public fully, we hope eventually to bring this cost down to 3 cents. Most of this reduction in costs will have to come through a decrease in overhead by increased volume (of traffic). It is thought that when helicopter transportation 10 to 15 years from now reaches the mark of $ 300,000,000 per year, the cost per passenger-mile will not be over 3 cents to 4 cents, thereby competing favourably with bus and rail travel."

Navy XHJD-1, twin-engine machine designed by McDonnell Helicopter Division of McDonnell Aircraft Corp.

What we have considered up to now is the bad news so far as current helicopter operations are concerned. The machine laps greedily at the black ink on the balance books. But it does so largely against a backdrop of conventional concepts of aircraft operation.

To repeat, this is no ordinary flying machine. For some purposes it may not at all be considered as a flying machine, but as an instrument which, only incidentally, is airborne in the course of its duties.

The evidence is in the record :

In the summer just past, parts of Sweden were afflicted with a bad visitation of caterpillars. The publication *Dagens Nyheter* stated on June 12th : "The present attack by the caterpillars is the worst." The firm of Hans Osterman, with offices in Stockholm, Malmo and Gothenburg, purchased three Bell Model 47 helicopters. The shipment of helicopters arrived during the night of June 9th-10th. In less than six hours they had been unloaded, assembled, and were in the air. In two days one of the machines had covered the whole island of Visingso.

Piasecki U. S. Navy machine seating 14 persons.

Kellet XR-10, new ten-seater helicopter of U. S. Army Air Forces. Note externally-placed air-cooled engines, and power shafts.

Was the helicopter worth $ 1,000, or $ 10,000 or $ 100,000 ? In such circumstances, on what basis is it to be evaluated economically ?

What will be the value of the Sikorsky S-51 just purchased by Hawaiian Airlines to accelerate communications among the six major islands of Hawaii ? The major part of the territory's population is concentrated on the single island of Oahu. Yet the other five islands are of major economic, political and social importance. With the exception of Oahu, each of the islands has only a single commercial airport. These ports are as much as 80 to 100 miles from some centres of population. Mountains abound.

How is one going to evaluate the helicopter in the presence of customers who have money to spend and don't mind spending it, or in the presence of the resourceful advertising man ? A New England department store paid handsomely for the use of helicopters on its 100th anniversary to deliver merchandise to 66 communities — to contrast its delivery by hand-cart a century before. Mrs. Joseph O. Ball, living near a snowbound community, was picked up last winter by helicopter and delivered to a hospital for the birth of a baby. How would an prospective and worried father figure the economics of the helicopter ?

At this stage of expanding helicopter employment, it is risky to put a currency sign on the machine to describe original investment or financial return. A study by Malcom G. Davis, vice-president of Gilbert Associates, an engineering and consulting firm, indicates that six-place machines can be operated, all overhead included, for less than 10 cents a passenger-mile. That would be less than is charged by the city-to-airport buses in America, and the service would be far faster.

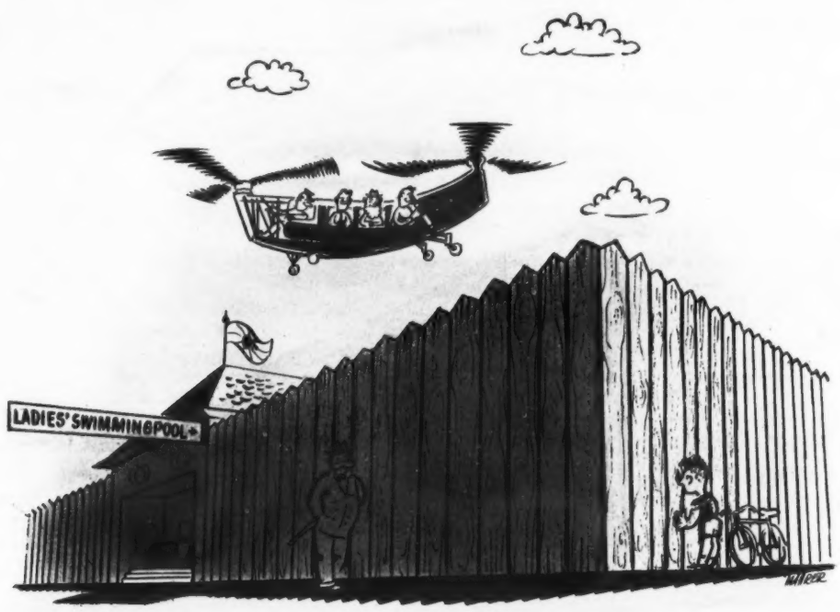
It is risky to make estimates when things happen such as happened at Camden the other day. An airliner, baffled by weather, sought asylum at the airport there. Two vexed passengers, bound for Washington, crawled out. They spied a helicopter belonging to Helicopter Air Transport on the other side of the field.

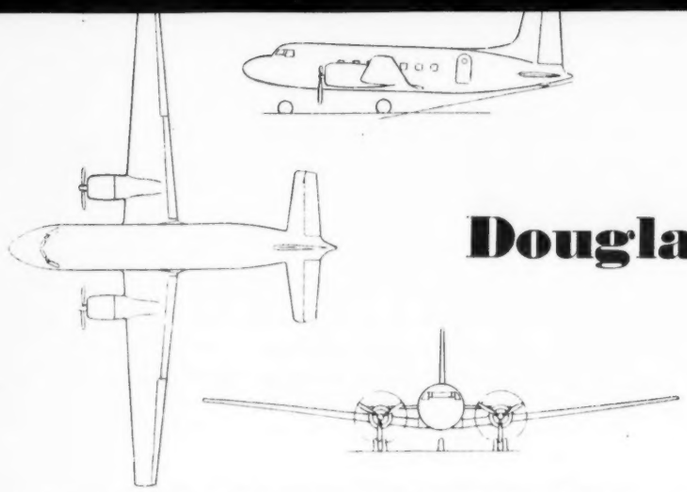
"What will you charge to take us to Washington ?" they asked in chorus.

"The weather isn't very good," demurred the H. A. T. representative.

"But your helicopter can fly in any kind of weather," urged the stranded travellers with an annoyed glance at the inert airliner they had just abandoned. "We've got to get to Washington. How much ?"

The price was steep. They paid without a murmur.





Douglas DC-9 Project

It is hard to imagine the air routes without the DC-3, which today flies the majority of medium- and short-range services. The day will have to come, however, as on December 17th, 1947, twelve years will have elapsed since the DC-3, represented by its first version, the DST ("Douglas Sleeper Transport," development of the DC-2, first flown in 1934), embarked on its highly-successful career. Competition, keen as it is at present, calls for the highest-performance equipment available; it is therefore logical that the new demands placed on a transport aeroplane are such that a twelve-year old construction can hardly be expected to make the grade.

Shortly after the end of the war the Douglas Company cancelled further production of the DC-3 and its military counterparts, the C-47 "Skytrain" and C-53 "Skytrooper," both known in Europe and the British Empire under the name of "Dakota," and concentrated chiefly on four-engined types, the renowned DC-4 and its bigger and more powerful successor, the DC-6. Meanwhile, these two models are not solely for long-range operations, but also for medium routes in instances of high traffic density, whilst the airline companies' requirements for short-range transportation are temporarily, and only barely, being covered with converted "Dakotas" acquired from U.S. surplus stocks.

Already some time before the war came to its close, a number of firms began studying the problem of which aircraft type stood the best chance of replacing the DC-3. The U.S. results are the Martin 2-0-2 and 3-0-3, and the "Convair-Liner" (formerly Convair 240); these are all designed to accommodate about forty passengers, are fitted with two engines of over 2,000 H.P. and feature gross weights of 38,000 to 40,000 lbs.

A few firms ventured to build special aircraft for short routes where traffic was low or irregular, for which the DC-3 tended to be too big. These were meant to represent roughly the smallest completely-equipped commercial aeroplanes with which scheduled operations could be undertaken on an economic basis, and were designed for carrying 8 to 14 passengers. In the U.S.A., at least, they did not meet with any great success, as they turned out to be too small to ensure profits even when flown at greater frequency over routes otherwise operated with DC-3's.

For those airline companies and routes for which the DC-3 was just right in size and operationally not too expensive, neither the new "big" twin-engined types fitted with the largest power plants available, nor the small transports mentioned above, seem to be entirely satisfactory. There is, therefore, an obvious gap to be filled.

Heretofore, Douglas had made no attempt to offer a new twin-engined commercial transport. There was talk at one time of a projected 48-passenger DC-8 fitted with two 1,625-H.P. engines and pusher airscrews, and of a 24-passenger "Skybus" high-wing monoplane for short hauls, with two small engines of 700 H.P. and weighing only 17,300 lbs. gross; thus two types corresponding in principle to the two designs mentioned earlier. However, Douglas never built them, not even as an experiment, but, to the astonishment of many aviation circles, chose to wait and see how post-war civil aviation would take shape.

Meanwhile, at the end of July, the Douglas Company announced that it was proposing a new twin-engined commercial transport, designated *DC-9*, as successor to the DC-3 as from 1949. Plans for this new passenger and cargo aeroplane have been discussed with a number of operators, but it is emphasised that the DC-9 represents a proposal only and a decision to produce it depends upon airline acceptance. The manufacturers all the same expect to be in a position to decide before the end of September, 1947.

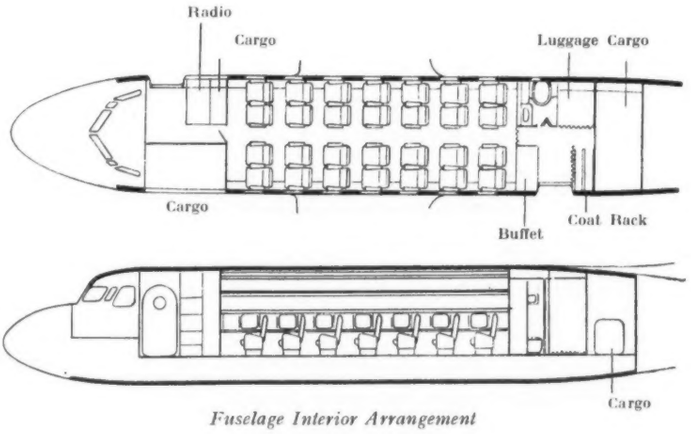
Contrary to other new twin-engined types, it is planned to power the DC-9 with the same engines which gave such good service in the DC-3: optionally, it can be equipped with Wright "Cyclone" nine-cylinder radials or Pratt & Whitney "Twin Wasp" fourteen-cylinder twin-row radials. During the course of the DC-3's twelve years, however, the take-off power of these two units has been stepped up: from 1,000 H.P. to 1,474 H.P. (and 1,525 H.P. with water injection) in the case of the "Cyclone" and to 1,650 H.P. in the case of the newest "Twin Wasp" with increased cylinder capacity.

Take-off weight and useful load of the DC-9 would each be 19 per cent higher than in the latest versions of the DC-3, thus not increased in the same proportion as the engine power. Power loading therefore works out, according to engine type, at 10 to 12 per cent lower.

The most noticeable and commercially most significant characteristic of the DC-9 is, of course, the augmented useful load: whereas the DC-2 contained 14 seats arranged in pairs and the DC-3, 21 in rows of three, the DC-9 is to accommodate *28 passengers* with the seats set out in seven rows of two seats on either side of the aisle.

A further respect in which the DC-9 is designed to meet all the latest requirements is that structural provision will be made for pressurising every part of the fuselage accessible in flight. The installation is not to be standard, however, but at the option of the purchaser. It would maintain internal cabin pressure altitude of 8,000 ft. up to 20,000 ft. flight altitude. In line with the latest design practice, the DC-9 is to have a nose-wheel undercarriage, the two main wheels retracting forwards and upwards into the engine nacelles and the steerable nose-wheel likewise forwards and upwards into the fuselage nose.

The fuselage is to be of circular section throughout, and of semi-monocoque construction. The projected interior arrangement is visible from the accompanying diagram. Normally, the crew will



Fuselage Interior Arrangement

comprise three members: pilot, co-pilot, and cabin attendant. Pilot's and co-pilot's seats are to be equipped with dual controls, but space provision will be made for installing an automatic pilot. The radio navigation equipment, worked from the pilots' seats but having the main components installed in a rack in the forward cargo compartment, is also to include a radio altimeter as standard fitting.

The wing is to feature a trapezoidal shape reminiscent of that of the Douglas A-26 " Invader " attack aircraft, but distinctly slenderer. It will have two spanwise shear webs taking the place of spars, whereas the bending forces are to be transferred chiefly by the sheet covering with spanwise stringers. The outer panels will be detachable outboard of the nacelles and will have detachable wing tips. The wing centre section, on the other hand, is to be integral with the fuselage. The latter will have Douglas-designed double-slotted partial-span wing flaps, hydraulically actuated and mechanically synchronised. The trailing edges of the outer panels will support long, slender ailerons, of metal except for the trailing edge which is to be of plastic-impregnated fiberglas. The landing flaps, incidentally, are to be entirely of metal. With the exception of the fabric-covered rudder, the tail group will likewise be of all-metal construction.

A thermal anti-icing system will send hot air, provided by internal combustion heaters, along the wing leading edges outboard of the nacelles and the leading edges of the horizontal and vertical stabilisers.

Mention was made earlier on of the projected power plant. If the nine-cylinder Wright " Cyclone " were selected it could, in order to increase the take -off output at the penalty of payload, be fitted with a water-alcohol injection device. Douglas, on the other hand, suggests a de-rated version of the same engine, of 7.5 per cent less rated power. This would give slightly more economic results on long distances, whilst the cruising speed at low altitudes would drop a little and the take-off run would become longer.

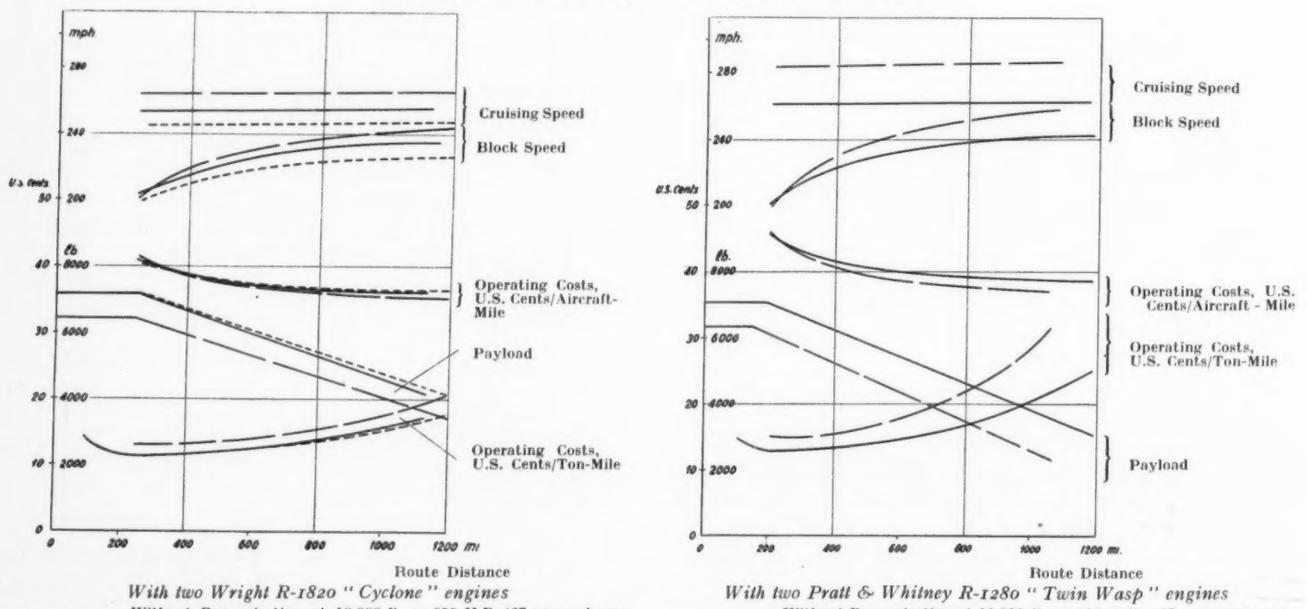
The airscrews are to be Curtiss electric types, reversible and electrically anti-iced.

Two collapsible cell-type fuel tanks will be located in the wing centre section between the engine nacelles and the wing roots. At the customer's request two additional cell-type tanks, of considerable capacity, can also be installed in the outer wing panels.

It might be premature to form any judgment of the new DC-9 on the basis of its design performance figures. According to the firm, its design cruising speed of 230 to 285 m.p.h., depending on the type of power plant, exceeds by far that of the DC-3 and easily meets the standards set by the airline companies. On the other hand, an aircraft of this category, which has also to call at small airfields, must conform to strict standards as regards landing and take-off distance. The wing loading of the DC-9 would be higher than that of the DC-3 and other short-range transports, but modest when compared with the recent larger twin-engined types; and its stalling speed is only 6 m.p.h. more than that of the DC-3. In contrast, the available summary data on take-off and landing distances, and on the climbing ability with one engine cut out, do not reveal how much shorter the DC-9's take-off and landing runways will be than those of the new larger types with higher wing loading and landing speed. The latter have frequently been attributed astonishingly good performance factors but, from the practical view-point, it is probable that these will place rigorous demands on airfield size. A reliable basis for comparison is, therefore, lacking on both sides.

Although the Douglas DC-9 only exists on paper for the present, its announcement is an event of which the significance should be valued more than the announcement of a new aircraft type by a smaller firm. Then, either the DC-9 will be produced in large series, or the project will be abandoned altogether. Meanwhile, if it does make its appearance, it may serve to prove an important principle of short-haul air transportation : frequent flights with smaller aircraft result in a greater saving of time for passengers than flights at longer intervals with heavy aircraft.

Design Speed, Payload and Operating Costs of the Douglas DC-9



With two Wright R-1820 " Cyclone " engines

———— Without Pressurisation at 10,000 ft. on 855 H.P. (67 per cent max. continuous power with low blower)

- - - - - - - - - - idem on 785 H.P.

— — — — — With Pressurisation at 17,800 ft. on 785 H.P. (70 per cent max. continuous power with high blower)

With two Pratt & Whitney R-1280 " Twin Wasp " engines

———— Without Pressurisation at 10,000 ft. on 938 H.P. (67 per cent max. continuous power with low blower)

— — — — — With Pressurisation at 21,000 ft. on 875 H.P. (70 per cent max. continuous power with high blower)

SPECIFICATIONS

MAIN DIMENSIONS

Span	101 ft. 0 in.
Overall length	70 ft. 8 in.
Height of fin	26 ft. 2 in.
Maximum cross-section	118 in.
Cargo space	357 cu. ft.

WING GROUP

Area (incl. ailerons)	850 sq. ft.
Chord at root	147.84 in.
Chord at tip	53.7 in.
Aspect ratio	12.0
Incidence at root	4 deg.
Dihedral	7 deg.

AILERONS

Span (each side)	22 ft. 9 in.
Area (total right and left)	68.2 sq. ft.

FLAPS

Span (each side)	23 ft. 2 in.
Area (total right and left)	137 sq. ft.
Maximum deflection	55 deg.

TAIL GROUP

Horizontal Surfaces :

Span	32 ft. 3 in.
Area (gross)	206.5 sq. ft.

Vertical Surfaces :

Area (gross, excluding dorsal fillet)	167 sq. ft.

LANDING GEAR

Track	25 ft. 2 in.
Wheel base (fore and aft)	21 ft. 0 in.

POWER PLANT

Engines :

Type	9-cylinder Wright " Cyclone " R-1820-C9HE	14-cylinder Pratt & Whitney " Twin Wasp " R-2180
Take-off (5 min) without water injection	1,475 B.H.P. at 2,800 r.p.m. up to 2,000 ft.	1,650 B.H.P. at 2,800 r.p.m. up to 3,000 ft.
with water injection	1,525 B.H.P.	—
Maximum continuous low blower	1,275 B.H.P. at 2,500 r.p.m. up to 3,500 ft.	1,400 B.H.P. at 2,600 r.p.m. up to 6,000 ft.
high blower	1,125 B.H.P. at 2,500 r.p.m. up to 10,600 ft.	1,250 B.H.P. at 2,600 r.p.m. u to 15,500 ft.

Airscrews :

Diameter	13 ft. 1 in.

Fuel Tanks :

Two main tanks, total volume	790 U.S. Galls.
Two additional tanks (optional)	550 U.S. Galls.
Maximum fuel supply	1,340 U.S. Galls.

Oil Tanks :

Two tanks, total volume (for operation with max. fuel supply)	46 U.S. Galls.
Normal oil supply	26 U.S. Galls.

AUXILIARY SYSTEMS

Electrical System : operating current	24-28 volts
Hydraulic System : operating pressure	3,000 lb./sq. in.

WEIGHT STATEMENT

	with Wright " Cyclone "	with P & W " Twin Wasp " R-2180
Weight empty (manufacturer's)	19,594 lbs.	21,194 lbs.
Useful load	10,406 lbs.	10,406 lbs.
Take-off weight	30,000 lbs.	31,600 lbs.
Wing loading	35.3 lb./sq. ft.	37.2 lb./sq. ft.
Power loading at take-off	10.17 lb./B.H.P.	9.58 lb./B.H.P.
Permissible landing weight	29,000 lbs.	30,600 lbs.
Useful Load Distribution at Full Payload :		
Passengers (28 at 165 lbs.)		4,620 lbs.
Passengers' luggage (30 lbs. each)		840 lbs.
Cargo		1,540 lbs.
Total payload		7,000 lbs.
Fuel (330 gallons)		1,978 lbs.
Oil (35 gallons)		263 lbs.
Crew and luggage		560 lbs.
Operating equipment		385 lbs.
Residual fuel and oil		220 lbs.
Total useful load		10,406 lbs.

DESIGN PERFORMANCE DATA

	with Wright " Cyclone "	With P & W " Twin Wasp " R-2180
Speeds :		
Cruising speed with low blower at 67 per cent maximum continuous power :		
at sea level	230 m.p.h.	237 m.p.h.
at boost altitude	257 m.p.h. at 11,600 ft.	268 m.p.h. at. 12,300 ft.
with high blower at 70 per cent maximum cruising power :		
at boost altitude	246 m.p.h. at 17,800 ft.	285 m.p.h. at 21,000 ft.
Stalling speed (flaps down)	73 m.p.h.	75 m.p.h.
Placard gliding speed	306 m.p.h.	320 m.p.h.
Climbing Performance :		
at max. continuous power		
Rate of climb at sea level	1,600 ft./min.	1,660 ft./min.
Service ceiling (100 ft./min.)	29,900 ft.	31,400 ft.
C.A.R. max. manoeuvring altitude	24,000 ft.	26,500 ft.
idem with one engine cut out	15,800 ft.	18,800 ft.
Take-off and landing :		
C.A.R. take-off field length at sea level without water injection	3,640 ft.	3,800 ft.
with water injection	3,540 ft.	—
C.A.R. landing field length at sea level	3,800 ft.	3,980 ft.
Theoretical Range :		
at normal take-off weight		
Cruising at 10,000 ft. with low blower		
with main tanks full	1,510 miles	1,280 miles
with max. fuel supply	2,580 miles	2,180 miles
Cruising at boost altitude with high blower		
with main tanks full	1,620 miles	1,430 miles
with max. fuel supply	2,770 miles	2,440 miles
Cruising on weak mixture at 10,000 ft. (average speed, 162-172 m.p.h.)		
with main tanks full	2,460 miles	2,110 miles
with max. fuel supply	4,390 miles	3,700 miles

T.

Aerodynamic Peculiarities of the Swept-Back Wing

By W. Just, D. Sc., and K. Sahliger, B. Sc. [1]

More and more interest is being evinced by the swept-back wing configuration as a means to achieve higher speeds. Heretofore, the only low-speed aircraft to which it has been applied are those of "all-wing" design; but it is currently being incorporated in many high-speed aeroplanes because the swept-back wing provides very little drag and its stability characteristics enable high Mach numbers to be attained. Since the advent of more powerful engines, such as jet-propulsion and rocket units, rather more value is attached to good stability than to drag economy, for it often occurs that modern aeroplanes cannot be flown with safety beyond a certain speed limit, despite the existence of an adequate power reserve. A great number of accidents involving ultra-high-speed aeroplanes may be coupled with this circumstance.

In contrast to the conventional wing, the swept-back type features a number of peculiarities, which may be separated into two main categories: those which effect the wing's behaviour at low speeds, and those which do not enter the aerodynamical picture until high speeds have been attained.

Behaviour of Swept-Back Wing at Low Speeds

Lift Distribution

To be able to judge the behaviour of the forces and moments imposed on a swept-back wing, which is necessary for calculating the flight performance and characteristics, and the problems of strength, we must first be acquainted with the lift distribution. There are already a number of systems in existence for calculating the lift distribution for swept-back wings, the best-known being those of *Weissinger* and *Multhopp*. According to the hypothesis of *Prandtl*, a supporting surface can be replaced by a system of attached and free vortices, whereby the surface of the attached vortices is approximately replaced by a vortex filament located at about 25 per cent chord. Fig. 1 illustrates a vortex system of this species in the case of the swept-back wing. Contrary to the normal wing without sweepback, the position of the attached and free vortices causes an increase in downwash from the wing centre section and a decrease from the outer wings; e.g., the attached vortex on the left-hand side induces downwash on the right-hand side, which is greater towards the interior than towards the exterior because of the shorter distance, whereas a conventional wing features no reciprocal induction of the attached vortices. Moreover, it may be seen from their geometrical position that, in swept-back wings, free vortices give rise to less downwash from the outer wings than in the case of ordinary wings. Thus the point is established that, in swept-back wings, the lift distribution $c_a \cdot t$ is higher towards the tips and lower towards the roots that in wings without sweepback. Fig. 2 gives a comparison of the lift distribution in the case of both swept-back and straight wings. It is recognised that the theory of *Weissinger*, which does not calculate with only one attached vortex, but with a superficial distribution of attached vortices, yields results substantially nearer to the measured lift distribution than does the method of *Multhopp*, which is content to replace the wing by a supporting vortex, but thereby reduces the amount of calculation necessary.

c_a (α) curve.

In a swept-back wing only the velocity component perpendicular to the $t/4$ line, $v_n = v \cdot \cos \varphi$, is effective as regards lift, and on the other hand, for geometrical reasons, the usually measured angle of incidence α for the wing section perpendicular to $t/4$ increases to $\alpha_n = \frac{\alpha}{\cos \varphi}$, so that a lift

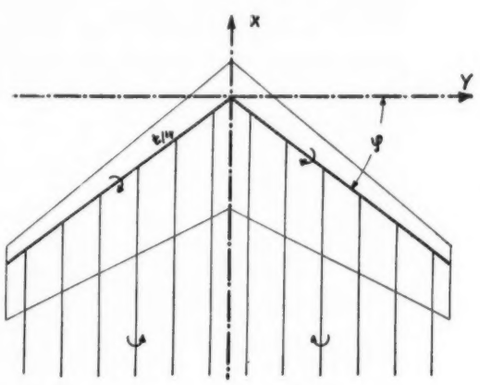


Fig. 1: Attached and free vortices in swept-back wing.

[1] This article is an extract from measurements executed and compiled by the authors, at present employed by SNCA du Sud-Est, whilst working as aerodynamicists for the Messerschmitt concern on the Me 163 and development of the Me 262.

Symbols:

b = span (m) $s = \frac{b}{2}$
F = wing area (m²)
Λ = b^2/F = aspect ratio
t = wing chord (m)
t_a = chord at tip
t_i = chord at root
t_E = reference chord for pitching moment (m)
α = angle of incidence
β = angle of drift
φ = angle of sweepback (25% t with transverse axis y)
v = air speed (m/sec)
q = $\frac{\varrho}{2} v^2$ = dynamic pressure
M = $\frac{v}{a}$ = Mach number
a = sonic speed
c_a = lift coefficient
c'_a = $\frac{\partial c_a}{\partial \alpha}$ = slope of lift curve
$c'_{a\infty}$ = c'_a for $\Lambda = \infty$
c_w = drag coefficient
c_M = pitching moment coefficient (+ = nose up)
M = $c_M \cdot q \cdot F \cdot t_E$ = pitching moment
C_L = rolling moment coefficient (+ = clockwise roll)
$L = c_L \cdot q \cdot F \cdot s$ = rolling moment.

Abbreviations:

AVA = Aerodynamische Versuchsanstalt Göttingen
DVL = Deutsche Versuchsanstalt für Luftfahrt Berlin-Adlershof
LFA = Luftfahrt-Forschungsanstalt Braunschweig
AJFH = Aerodynamisches Institut für Flugtechnik Hannover
Lufo = Luftfahrtforschung
FB = Forschungsberichte der deutschen Luftfahrtforschung (ZWB)
UM = Untersuchungen und Mitteilungen der deutschen Luftfahrtforschung (ZWB)
LGL = Lilienthal-Gesellschaft für Luftfahrtforschung

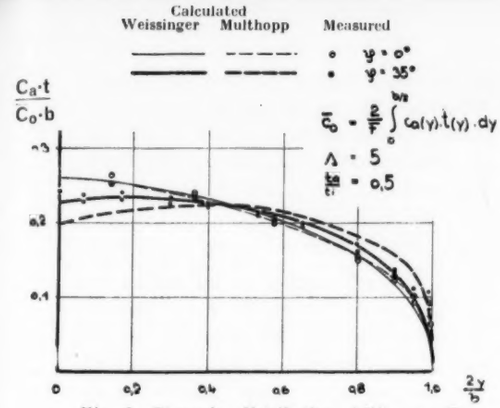


Fig. 2: Spanwise distribution of lift $c_a \cdot t$. Comparison between measurement (DVL) and calculation for wings with and without sweepback.

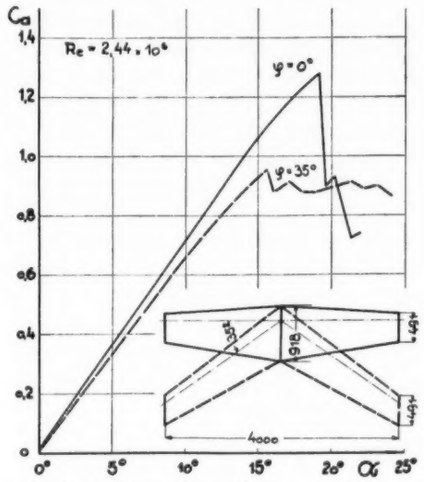


Fig. 3: Influence of sweepback on c_a (α) curve (DVL).

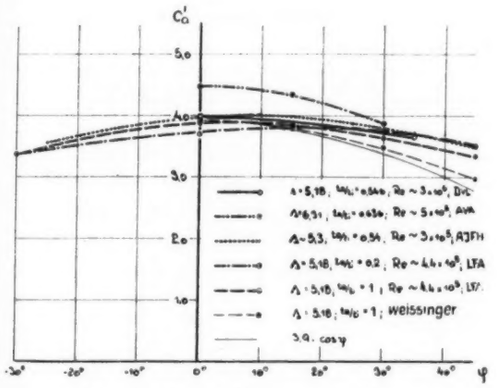


Fig. 4: Slope of lift curve c'_a against angle of sweepback.

decrease results which is approximately proportional to cos φ. This proportion, however, is only valid for a straight drifting wing, thus for one half of a swept-back wing. As the centre portion of a swept-back wing is not affected by this decrease, the proportion for the entire swept-back wing is not as high as cos φ. For the same reason, the decrease in c'_a owing to sweepback is smaller in a trapezoidal wing than in a rectangular type, because in the former the large wing portions are located centrally. Similarly, this also applies to small aspect ratios.

Fig. 3 gives a comparison between measurements taken on wings with and without sweepback. The slope of lift curve, c'_a, is shown in Fig. 4 in function of the swept-back wing. It can be seen that the decrease is in a proportion of less than cos φ.

$c_{a\ max}$

In the case of the lift distribution it has been seen that the lift, contrary to wings without sweepback, moves towards the exterior. Fig. 5 shows the spanwise distribution of c_a in accordance with the $c_a \cdot t$ distribution (Fig. 2). We can deduce that the flow in the case of swept-back wings will invariably endeavour to break away at the tips first, and at lower mean c_a values than with straight wings. Moreover, because the pressure distribution is staggered due to the sweepback, there is a fall in pressure on the upper surface towards the tips, with the result that the boundary layer, sucked off in the direction of the tips, heaps up on the outer wings. This heaping of the boundary layer together with the c_a increase resulting from the lift distribution causes, in swept-back wings, an earlier breakaway from the outer wing than in straight-type wings. On the other hand, the wandering of the boundary layer towards the tips gives rise to an increase in local $c_{a\ max}$ for the inner part of the wing. Both effects overlap, so that at small Reynolds numbers, at which the breakaway towards the centre occurs slower than the $c_{a\ max}$ rise in the middle part, the swept-back wing is the object of higher mean $c_{a\ max}$ values than the ordinary wing, whilst the opposite effect takes place at high Reynolds numbers (cf. Figs. 6 and 7). The breakaway character is plotted against different Reynolds numbers in Fig. 8. For the purpose of comparison, the character of c_a in function of α is also shown for a straight wing and a medium Reynolds number. How the breakaway begins is best shown by the c_M (c_a) curve.

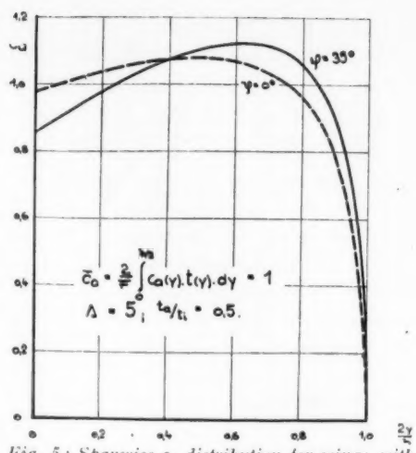


Fig. 5: Spanwise c_a distribution for wings with and without sweepback.

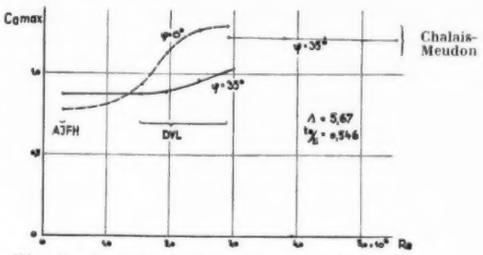


Fig. 6: Reynolds influence on $c_{a\ max}$ for φ = 0° and 35°.

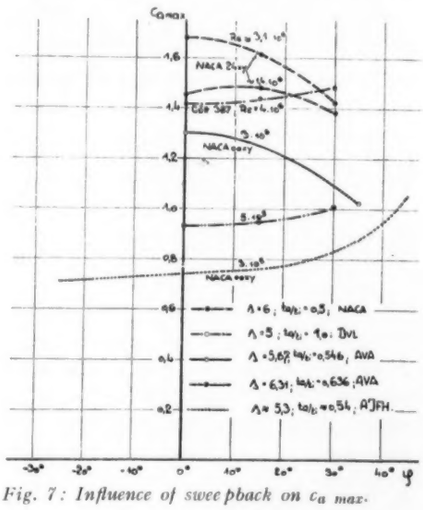

Camax
NACA 23012
NACA 0012
Göe 387
NACA 0009
Λ = 6; t₀/t₁ = 0,5; NACA
Λ = 5; t₀/t₁ = 1,0; DVL
Λ = 5,67; t₀/t₁ = 0,546; AVA
Λ = 6,31; t₀/t₁ = 0,636; AVA
Λ = 5,3; t₀/t₁ = 0,54; AJFH

Fig. 7: Influence of sweepback on $c_{a\ max}$.

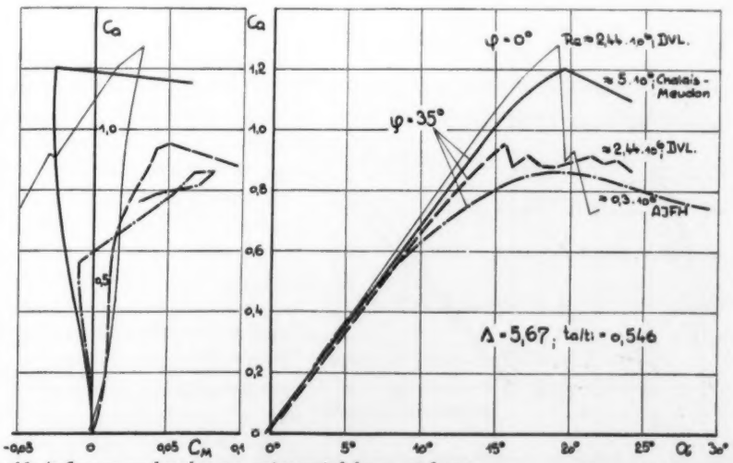


Fig. 8: Reynolds influence on breakaway, represented by c_a and c_M.

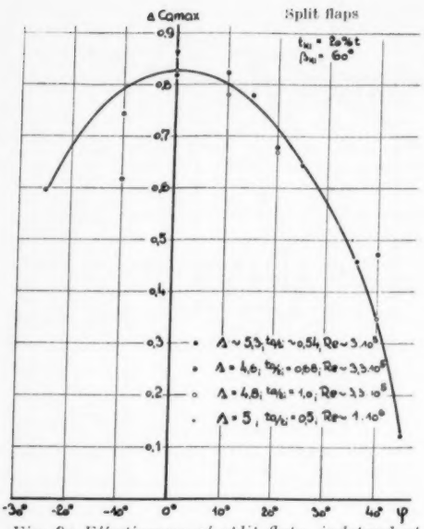


Fig. 9: Effectiveness of split flaps, independent of sweepback.

As in the case of $c_{a\ max}$ without flaps, there is also a strong $c_{a\ max}$ decrease with flaps, due to the sweepback. Fig. 9 contains a series of measurements to illustrate this circumstance.

Dropping of Wings.

The above-described breakaway at the wing tips is highly undesirable for two reasons :

1) the wing cannot be designed against dropping and thus lacks a safety feature demanded of every aircraft ;

2) contrary to ordinary wings, the breakaway in swept-back wings involves very great and sudden nose-up moments, which can be extremely dangerous during landings, take-offs and curves.

In order to eliminate both these dangers, designers are having to turn more and more to auxiliary means of causing the breakaway to start further towards the centre of the wing. The best-known means are the following :

1. Feeble tapering ; thus largest possible chord at tips.
2. Forced breakaway at the centre by means of small leading edge radii for the wing centre section.
3. Sucking or blowing off in the outer wing region.
4. Leading-edge auxiliary aerofoils in the outer wings, leading-edge slats, slotted wings.

Owing to the sensitivity of these arrangements, it will be necessary, in order to establish sure statements, always to refer to measurements at highest possible Reynolds numbers. As examples, here are a few measurements made on swept-back wings with leading-edge auxiliary aerofoils, such as were used on the Me 163 rocket fighter and the development of the Me 262 twin-jet fighter. From Fig. 10, drawn from photos of flows, can be seen how the application of a leading-edge auxiliary aerofoil can clean up the flow over the outer wing. Fig. 11 shows c_a in function of α and c_a in function of c_M for a 35-deg. swept-back wing without a leading-edge auxiliary aerofoil, with a leading-edge slat on the outer wing, and with a leading-edge slat extending over the entire span. The c_M curves reveal, from the

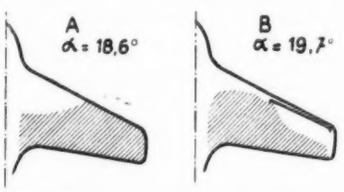


Fig. 10: Breakaway with and without outer leading-edge auxiliary aerofoils. AVA measurement on Me 163.

nose-up tendency of the moment, that the breakaway begins at the outer wings in a wing without leading-edge aerofoil, whereas there is an opposite tendency in wings with outer leading-edge aerofoils. The full-span slat gives rise to a greater gain in $c_{a\ max}$, but it cannot be used fully because of the breakaway danger ; the outer leading-edge aerofoil alone makes the wing proof against dropping, but causes no gain in $c_{a\ max}$. Analogous circumstances exist in the case of slotted wings and wings fitted with leading-edge slats.

c_M — Neutral Point

The moment course in the region not affected by the breakaway action can best be characterised by indicating the neutral point. As is known, the neutral axis is the axis for which the moment coefficient of the entire wing is constant for at least one certain c_a region. The measurements of c_M, referred to any axis, yield an almost straight curve for $c_M(c_a)$, (cf. Fig. 12), which we can define (referred to the measurement axis) with the following equation :

$$c_{M_a} = c_{M_o} + \frac{\partial \cdot c_{Ma}}{\partial c_a} \cdot c_a$$

If we now calculate the moment coefficient on an axis located at $\frac{\Delta x}{t}$ before the reference axis of measurement, we obtain a new moment coefficient :

$$c_{Max} = c_{Mo} + \frac{\partial c_{Ma}}{\partial c_a} \cdot c_a - c_a \cdot \frac{\Delta x}{t}$$

By choosing $\frac{\Delta x}{t}$ so that $\frac{\Delta x}{t} = \frac{\partial c_{Ma}}{\partial c_a}$, we then obtain for this reference axis, or the neutral axis :

$$c_{MN} = c_{Mo} = \text{constant}$$

Thus it is always the value obtained by measurement of $\frac{\Delta x}{t} = \frac{\partial c_{Ma}}{\partial c_a}$ that gives the position of the neutral point fore of the measurement axis.

Fig. 13 shows the neutral point positions for trapezoidal wings with up to 45 deg. sweepback, obtained in wind-tunnel measurements. For the chord of reference, that chord was chosen which has always proved reliable in wings without sweepback, namely, that obtained by calculation under the condition of constant c_a distribution over the total span. This reference chord, $t_E = \frac{1}{F}\int_{-b/2}^{+b/2} t^2 \cdot dy$

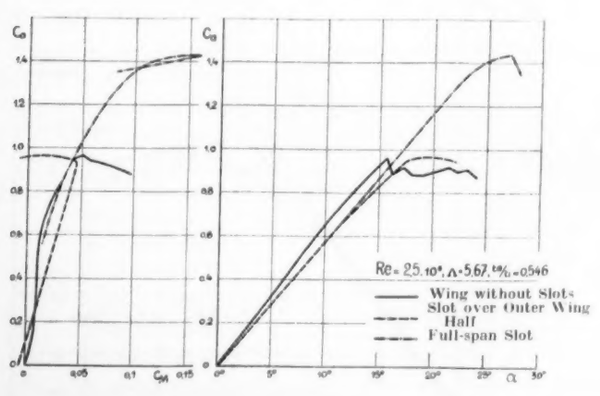


Fig. 11: Influence of leading-edge aerofoils of different length on c_a and c_M ; AVA measurement.

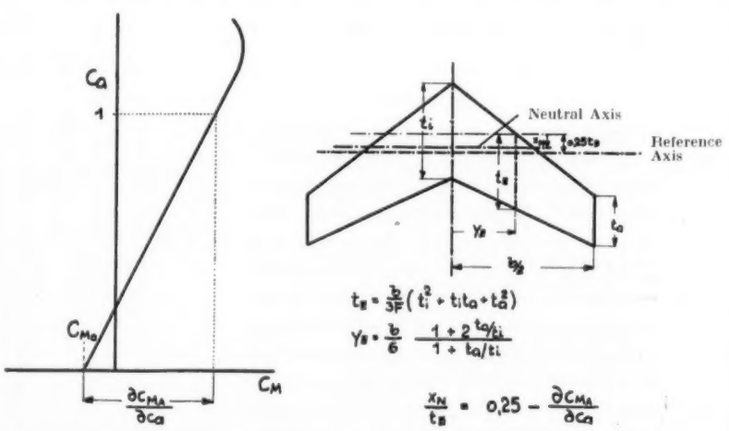


Fig. 12: Definition of the moment-reference-chord and determination of the neutral point from a measurement.

is, in simple trapezoidal wings, equal to the chord at ½ surface centre of gravity (cf. Fig. 12). It should be remembered that, in wings with large outer chords, thus designed against dropping, the neutral point quickly wanders forwards as the sweepback increases, whereas an opposite procedure takes place in strongly-tapered wings ; this is important, for stability reasons, in defining the positions of the centre of gravity.

Unsymmetrical Flow.

Space prohibits a complete description of all the influences of sweepback in the case of unsymmetrical flow, such as in drifting, rolling and yawing, which alter the drift-rolling moment, yaw-rolling moment, drift-yawing moment, and yaw damping, and which must be taken into account in calculating the lateral stability. Only the most obvious and significant influence will be treated here, namely, the effect of sweepback on the drift-rolling moment. To produce a proper drift-rolling moment, the usual practice is to give a wing upward dihedral, about 6 deg. in low-wing monoplanes. As the sweepback alone contributes substantially towards producing a drift-rolling moment, the dihedral has to be made considerably less. At large angles of sweepback, of about 30 to 40 deg., no dihedral at all is necessary. The additional contribution of the sweepback to the drift-rolling moment may be obtained from :

$$\triangle L = \left(\frac{c'_{L\beta\varphi}}{tg\varphi \cdot c_a}\right) \cdot tg\varphi \cdot c_a \cdot \beta \cdot F \cdot s \cdot q$$

$c'_{L\beta\varphi} = \dfrac{\partial c_{L\varphi}}{\partial \beta}$ with $c_{L\varphi}$ = rolling moment coefficient divided by sweepback φ

φ = angle of sweepback

β = angle of drift

s = semi-span

The value $\dfrac{c'_{L\beta\varphi}}{tg\varphi \cdot c_a}$ is plotted in Fig. 14 in function of the aspect ratio Λ, according to calculations and measurements.

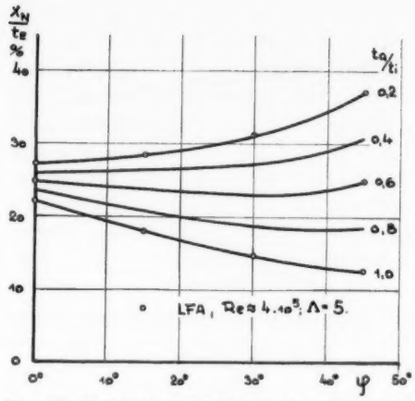


Fig. 13 : Neutral point positions for a trapezoidal wing, against sweepback.

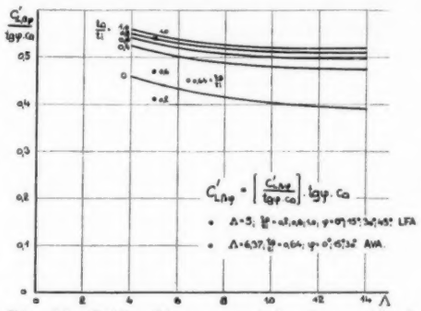
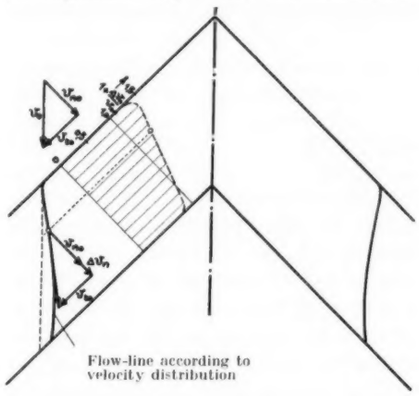


Fig. 14 : Drift-rolling moment due to sweepback for trapezoidal wing ; theory and measurement.



v_o = flying velocity ; v_{on} and $v_{o\tau}$ = normal and tangential components ; $\triangle v_n$ = local speed increment in direction n

Fig. 15 : Flow-lines on swept-back wing ; clarifying effect at centre section.

Additional Influence at High Speeds

If the velocity of the flow against an aerofoil is raised in such a manner that locally, about in the region of maximum aerofoil thickness, sonic speed is attained and exceeded, the deceleration from supersonic to subsonic speed aft of the thickest point does not proceed gradually but produces a sudden rise in pressure, a so-called compressibility shock. This causes a disturbance and, finally, a breakaway of the boundary layer behind it. Coupled with this breakaway is a sharp increase in drag and, in the case of usual aerofoils, a sudden nose-down tendency of the aerofoil, which have hitherto ruled out flight at such high Mach numbers. It is interesting to note that test pilots said of the Me 163 that this moment disturbance was so sudden that the aircraft almost turned tail over nose and the pilot lost control completely for some time. For this reason an endeavour is always made to have the compressibility shock delayed until highest possible speeds have been reached. One possibility of achieving this, to a certain degree, is by using swept-back wings. As, according to *Professor Betz*, a compressibility plane can only be produced by the velocity components perpendicular to the compressibility plane, then in a swept-back wing, only the velocity components running perpendicular to the line of maximum aerofoil thickness, which amounts to approximately v.cos φ, have an effect on the compressibility plane. Due to this effect, therefore, the Mach number at the beginning of the breakaway should augment to about $\dfrac{M}{\cos\varphi}$, though only for the outer wings. In the wing centre section, of course, this principle can no longer be applied. Here, logically enough, an increase in the over-velocity occurs, which is to the detriment of the Mach behaviour of swept-back wings. If, as already shown above, we separate the velocity of flow into the two components perpendicular and parallel to the wing, the component running in the direction of the wing remains unchanged whilst, due to evasive and circulation flow movements, the perpendicular component is subjected to modifications which cause a bulge in the flow (cf. Fig. 15). This convergence of the flow lines causes an increase in speed and thus a decrease of the critical Mach number at the centre section, compared with the outer wings ; in swept-back wings the critical Mach number remains well below the value $\dfrac{M\ cr\ \varphi = o}{\cos\varphi}$.

The Amplified Prandtl's Rule

On the basis of theoretical calculations we can already make a few statements on the behaviour of forces imposed on a wing at high speed, taking the compressibility into account. The rule of Prandtl, amplified by *Gœthert*, maintains that the flow around an aeroplane travelling at high but subcritical speed can be calculated in approximation by replacing the real aeroplane with a fictitious aeroplane whose coordinates perpendicular to the direction of flow are shortened by the factor $\sqrt{1-M^2}$, whereby the velocity of flow is maintained constant and the pressure is augmented by the factor $\dfrac{1}{1-M^2}$ (cf. Fig. 16). By introducing the index 1 for the comparative aeroplane, we obtain the following relations :

$$x_1 = x$$

$$y_1 = y \cdot \sqrt{1-M^2}$$

$$z_1 = z \cdot \sqrt{1-M^2}$$

and thus the following geometrical characteristics for the comparative aeroplane :

length/wing chord $l_1 = 1$ and $t_1 = t$

span $b_1 = b \cdot \sqrt{1-M^2}$

area $F_1 = F \cdot \sqrt{1-M^2}$

aspect ratio $\Lambda_1 = b_1^2/F_1 = \Lambda\sqrt{1-M^2}$; $\Lambda = b^2/F$

height or aerofoil thickness $d_1 = d \cdot \sqrt{1-M^2}$

angle of incidence $\alpha_1 = \alpha \cdot \sqrt{1-M^2}$

angle of sweepback $tg\varphi_1 = tg\varphi \Big/ \sqrt{1-M^2}$

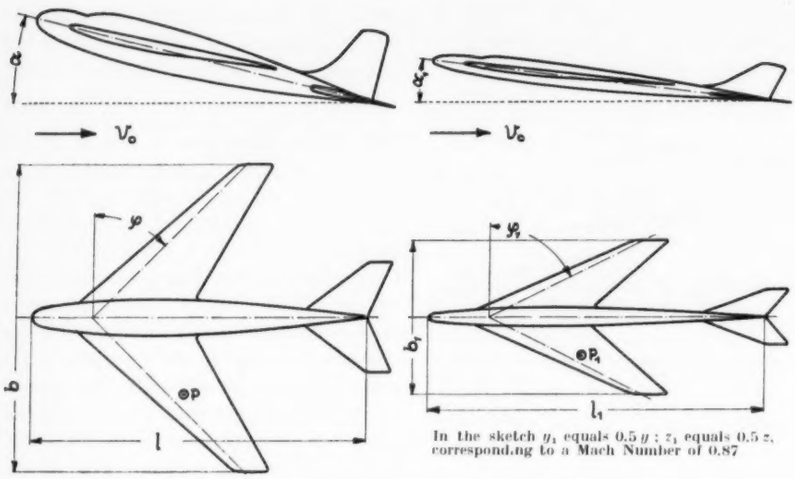


Fig. 16: Fictitious aeroplane, according to amplified rule of Prandtl.

Once this aeroplane 1 has been calculated in the usual manner, we will have established the aerodynamic values c_{a1}, c_{M1} and pressures p_1. From these values we can subsequently obtain, for the real aeroplane, the aerodynamical coefficients from :

$p = \frac{p_1}{1-M^2}$ for the points P and P_1 corresponding to each other.

$c_a = \frac{c_{a1}}{1-M^2}$

$c_M = \frac{c_{M1}}{1-M^2}$

c_a coefficient

For the slope of lift curve $c'_a = \frac{\partial c_a}{\partial \alpha}$, for example, we obtain :

$$c_a = c'_a \cdot \alpha = \frac{c_{a1}}{1-M^2} = \frac{c'_{a\infty} \cdot \alpha \cdot \sqrt{1-M^2}}{\left|1 + \frac{c'_{a\infty}}{\pi \Lambda \sqrt{1-M^2}}\right| (1-M^2)}$$

$$c'_a = \frac{\frac{c'_{a\infty}}{\sqrt{1-M^2}}}{1 + \frac{c'_{a\infty}}{\sqrt{1-M^2}} \cdot \frac{1}{\pi \Lambda}}$$ for large aspect ratios.

Taking into account the superficial lift distribution according to *Multhopp*, c'_a may be expressed more accurately :

$$c'_a = \frac{1}{\left(\frac{1}{c'_{a\infty}} + \frac{1}{2\pi}\right)\sqrt{1-M^2} + \frac{1}{\pi \Lambda}\left[1 + \sqrt{1 + \frac{\Lambda^2}{4}(1-M^2)}\right]}$$

From the calculation of the lift distribution, it may be deduced that for a swept-back wing, except for the centre section, the conventional formulæ can be used if $c'_{a\infty}$ is replaced with $c'_{a\infty} \cdot \cos \varphi_1$. The resultant relations are plotted in Fig. 17, with the result that the slope of lift curve c'_a can be read off for any Mach number, angle of sweepback and aspect ratio. Meanwhile, as these relations are not valid for the wing centre section, we must be careful how we use the curves. Fig. 18 shows the c'_a values for an aspect ratio $\Lambda = 6$ and angles of sweepback $\varphi = -35^\circ$, 0°, 35° and 50°, plotted against the Mach number. Fig. 19 contains c'_a for $\varphi = 35^\circ$ and aspect ratios $\Lambda = 3$, 6 and 9, likewise plotted against the Mach number.

c_w coefficient (drag)

In order to show the influence of sweepback at high Mach numbers, Fig. 20 gives values obtained by measurement with $\Lambda = 6$ and an aerofoil of NACA 00012-1.1-30 (measured in the direction of flight) for $\varphi = 0^\circ$ and $\varphi = 35^\circ$. It may clearly be seen that a wing with a sweepback $\varphi = 35^\circ$ allows for a Mach increase of $M = 0.08$, which means a speed increase of $V = 100$ km/h in ground vicinity. According to the *cos* law, from the Mach number of the initial drag increase, about $M = 0.75$ for a wing without sweepback, there ought to result a Mach gain of $M = \frac{0.75}{\cos \varphi} - 0.75 = 0.17$. Due to the unfavourable effect in the centre section, however, this value is cut down by about one half. The fact that these disturbances originate from the centre section has been substantiated by momentum measurements. At low speeds the c_w difference between wings with and without sweepback is very small, the sweptback wing being somewhat better around $c_a = 0$, but less favourable than the straight wing at high c_a values owing to its inferior induced drag.

Fig. 20 also shows the drag behaviour of a wing without sweepback of the extremely low aspect ratio $\Lambda = 1.15$, which features almost the same favourable Mach behaviour

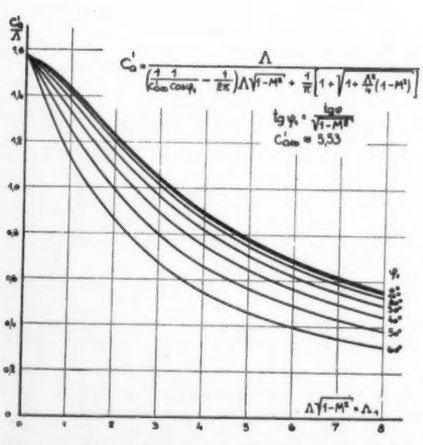

$c'_a = \frac{\Lambda}{\left(\frac{1}{c'_{a\infty}\cos\varphi_1} - \frac{1}{2\pi}\right)\Lambda\sqrt{1-M^2} + \frac{1}{\pi}\left[1+\sqrt{1+\frac{\Lambda^2}{4}(1-M^2)}\right]}$
$\frac{\tan\varphi}{\sqrt{1-M^2}} = \Lambda_1$
$c'_{a\infty} = 5{,}53$
$\Lambda\sqrt{1-M^2} = \Lambda_1$

Fig. 17: Slope of lift curve c'a, with sweepback and taking Mach number into account; Multhopp's theory on superficial distribution of vortices.

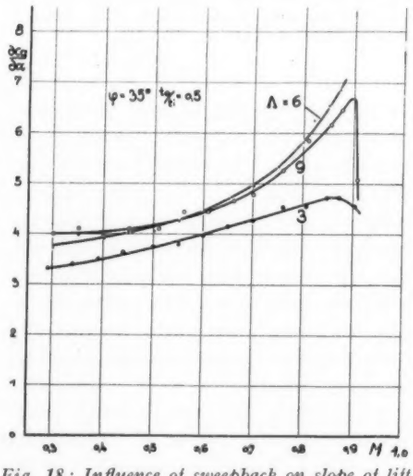


Fig. 18: Influence of sweepback on slope of lift curve c'a at high Mach numbers. DVL.

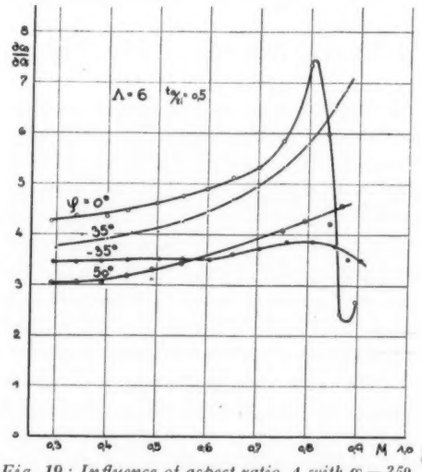


Fig. 19: Influence of aspect ratio Λ with φ = 35° on c'a at high Mach numbers. DVL.

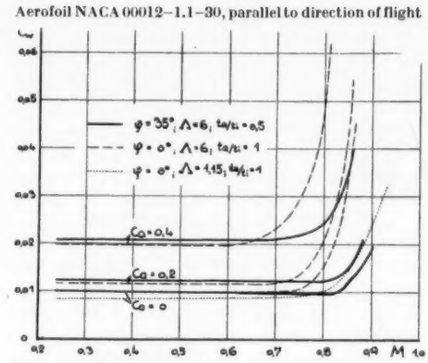


Fig. 20: Improvement of critical Mach number, due to sweepback.

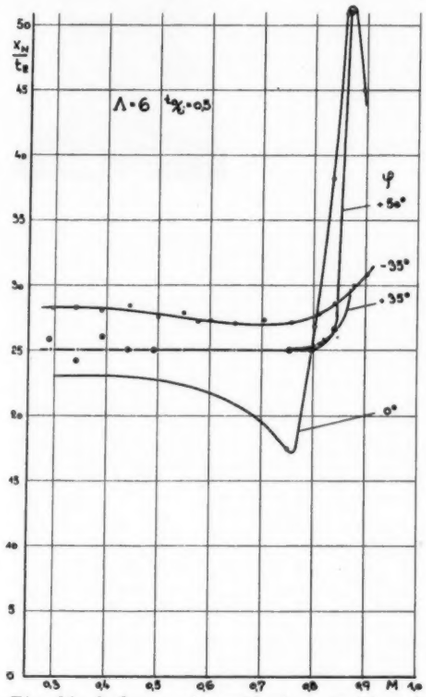


Fig. 21: Influence of sweepback on position of neutral point, $\frac{x_N}{l_E}$ at high Mach numbers. DVL.

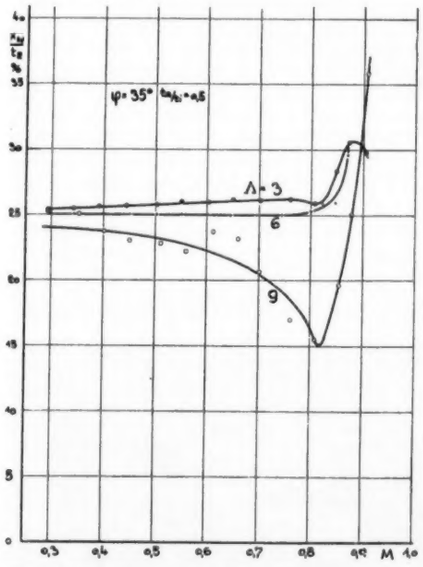


Fig. 22: Influence of aspect ratio Λ at φ = 35° on position of neutral point at high Mach numbers.

as the sweptback wing of $\varphi = 35°$ and $\Lambda = 6$; this is due to the three-dimensional flow. From this we may deduce that, for still greater flight speeds, the most desirable wing configuration is a swept-back type of very low aspect ratio. In order to reduce the particularly detrimental effect in the centre section, it suffices to incorporate a normal, good fuselage, which enables the critical Mach number to be postponed to some extent. Attempts have been made to achieve a further Mach increase by suiting the sides of the fuselage to the flow line curvature mentioned above. From these considerations it follows that, under given circumstances, an all-wing aeroplane can reveal a Mach behaviour inferior to that of an aeroplane with a well-designed fuselage and otherwise the same wing.

c_M coefficient

Here again, the best way of showing the course of the moment is by indicating the position of the neutral point which, in the case of symmetrical aerofoils, is identical with the centre of pressure. From Fig. 21 we can see that, for a wing without sweepback, the neutral point wanders forwards as the Mach number increases, thus pointing to instability; this of course couples with boundary layer influences. According to Prandtl's rule, the angle of sweepback for the usually-calculated comparative aeroplane must be chosen larger as the Mach number increases. Thus, it may be deduced from the calculation of the lift distribution that the swept-back wing causes a continual displacement of the lift towards the tips. The forward wandering of the neutral point for the separate wing section is compensated by a wandering back due to the increased sweepback, which proceeds in such a manner that, at large angles of sweepback, the neutral point remains constant until high Mach numbers are reached; then, it does not drop so suddenly, which simplifies the pilot's task. This favourable behaviour of the moments in the case of swept-back wings is thus advantageous if high speeds are to be attained. The positions of the neutral point for wings with the same sweepback but of different aspect ratio are shown in Fig. 22. This diagram confirms what has already been stated above, namely, that high aspect ratios exercise an unfavourable influence on the moment behaviour.

In order to show, by means of an example, to what extent flight measurements coincide with wind-tunnel measurements, the Mach number at which the Me 163 started becoming nose-heavy (thus the highest Mach number attainable in flight) is plotted in the wind-tunnel measurement (Fig. 23). As can be seen, the coincidence in the case of the Me 163 is well nigh perfect.

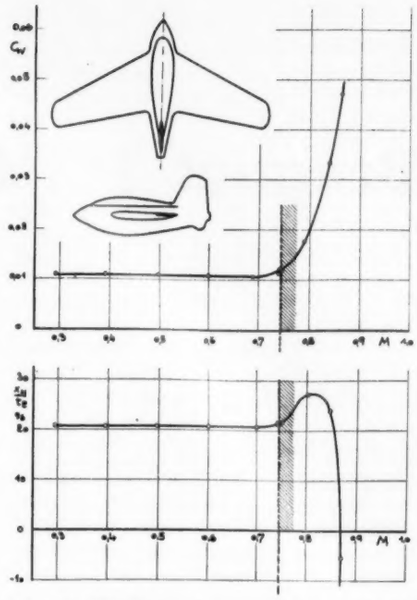


Fig. 23: Wind-tunnel measurement on Me 163 for c_w and neutral point positions above Mach. Highest Mach number plotted is highest Mach number attainable in flight. F = 19.6 m², b = 9.3 m; maximum thrust = 1,500 + 300 kg; gross weight G ≈ 2,500 kg.

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Bréguet 761 Cargo Transport

Ateliers d'Aviation Louis Bréguet, the well-known French aircraft manufacturing concern at Villacoublay, near Paris, is currently completing the prototype of a four-engined all-metal cargo transport aircraft, the Bréguet 761, which is to be test-flown next November. Compared with other aircraft of its type, size and engine output—for example, the Aerocentre NC 211 "Cormoran" which the Société Nationale de Constructions Aéronautiques du Centre has also nearly completed [1]—the Bréguet 767's chief distinction is that its fuselage is divided into two decks. The paragraphs below, furnished by the manufacturers, explain the reasoning behind the particular dimensions and structural configuration of this new cargo transport. Its construction, not described here, is based on vast experience gathered by this firm; the wing, for instance, has been derived directly from that of the 28-ton Bréguet 730, a four-engined flying-boat developed shortly before the war for the Navy, which features roughly the same dimensions as the new Model 761.

Louis Bréguet, the man responsible for this new aircraft, was one of the first to examine and establish on a numerical basis, the relation between the characteristics of an aircraft and its operational costs.

Louis Bréguet

In order to keep the operational costs of an aeroplane as low as possible, the designer must endeavour to make the constructional weight as low as possible, the drag coefficients also as low as possible, and to obtain a maximum degree of airscrew efficiency; then, he must select optimum values for the gross weight, wing loading, lift coefficient and aspect ratio of the wing, cruising speed and, finally, for the length of the route sections over which the aircraft must be operated. A judicious choice of these values is of great benefit to the project. As regards the total weight, for instance, if we assume the same coefficient of volume exploitation for two aeroplanes, 40 tons is decidedly more economical than 20 tons; at weights of over 40 tons, however, the advantages quickly become less apparent, and the aircraft's adaptability to changing conditions is lessened.

With these considerations in mind, the designers chose a gross weight of the order of 40 tons for the Bréguet 761. The fuselage form is a compromise between largest interior volume, utilisable to a maximum, and smallest structural weight.

Apart from the characteristics mentioned here, it is most important that the aircraft be equipped so as to allow loading and unloading to proceed with ease and rapidity, notably in order to reduce expensive waiting time at terminals. It is consequently the designers' duty to seek the most satisfactory compromise between volume, ease of access, floor space, loading and unloading and stowing facilities on the one hand, and the most favourable aerodynamic qualities on the other.

It is interesting to note which kinds of cargo, under present-day economic conditions, lend themselves best to transportation by air. First of all come those goods of which the sales value is contingent upon the speed with which they are delivered, such as flowers, fruit, vegetables, meat and other perishable commodities. After these follow goods of which the sales price is in line with the cost of transportation by air.

If the aircraft is to be given access to as many fields of application as possible, we must take into account an average density for the commodities liable to be transported by air, not forgetting their usual packing. Including the packing, it is likely that this will be well above 6.25 lb./cu.ft. in the majority of cases, as the following examples may serve to prove:

Mail shipments:
between 6.25 and 12.5 lb./cu.ft.
Fresh meat (e.g. mutton):
between 6.25 and 12.19 lb./cu.ft.
Luggage: between 8.13 and 26.25 lb./cu.ft.
Raw cotton, hemp, jute, wool:
between 9.06 and 26.25 lb./cu.ft.
Fruit in boxes:
between 18.75 and 43.75 lb./cu.ft.

Experience has shown, meanwhile, that the room taken up by the cranes and winches for handling cargo, as well as the space which must be left for accessibility reasons, makes full utilisation of the available space impossible. It is advisable, therefore, to choose an average density considerably below that of the majority of goods; and less than 6.25 lb./cu.ft. will produce the best results.

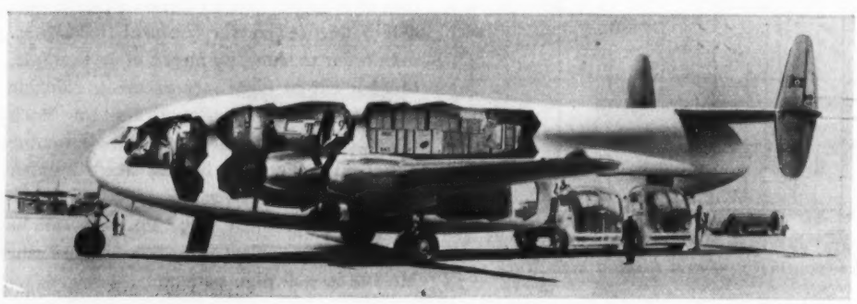
Thus it may be deduced that a cargo hold of a given volume must be provided with a maximum of floor area in order to facilitate loading and stowing within the fuselage.

The demands for ample cargo space in relation to payload and for plenty of floor space led up to the double-deck fuselage of the Bréguet 761, which provides 5,897 cu. ft. of space and a floor area of 753 sq. ft. for a payload of 13 tons. This permits the aircraft's payload to be fully exploited with goods of only 5 lb./cu.ft. density, which, as a theoretical value, is superior to that offered by many cargo aircraft in use today.

In calculating the strength of the hold floor of the Bréguet 761, the designers took into consideration the various types of cargo which might be carried; as a result, the floor is designed to withstand strains of up to 123 lb./sq.ft. The forward part of the hold has a safety coefficient of 4.15; the rear part, which is subjected to additional vertical accelerations, has a safety coefficient of 5.6. It is interesting to note in this connection that road bridges are also calculated to withstand strains of up to 123 lb./sq.ft.

Provided that each of the decks has sufficient headroom (about 7 ft.), the double-deck fuselage configuration offers interesting opportunities for equipping a part or all of one of the decks for passenger accommodation.

The clam-shell opening at the rear has two pairs of doors which are parts of the lower rear fuselage sides.



[1] Cf. "Interavia, Review of World Aviation" No 1, January, 1947, P. 44-46.

The demands resulting from these operational considerations do not clash with the optimum general characteristics of the aircraft. In particular, the double-deck design of the fuselage combines extremely well with the mid position of the wing, resulting in an excellent aerodynamic interaction between wing and fuselage, allowing for short undercarriage struts to be fitted without impeding airscrew clearance, and leaving little height between fuselage belly and ground.

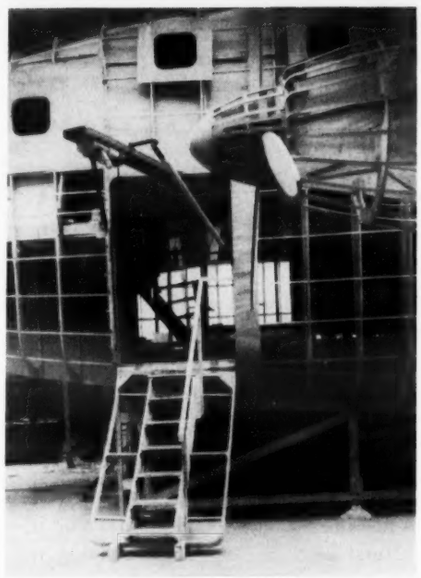
Another obvious advantage of the double-deck configuration is, of course, that loading and unloading operations can be carried out separately and simultaneously for each deck. For this purpose there is a wide clam-shell opening at the rear, sealed off by two pairs of doors ; each pair of doors is opened and closed hydraulically, an electric pump driven by an A.C. current of 220 volts serving as pressure source, and a hand pump being provided in case this system should fail. The loading doors open sideways and upwards to the height of the upper deck, where a locking device holds them in position. There is then 12 ft. 3½ in. of clearance between the top deck and the ground, enabling very high lorries to be driven right up to the hold. Beneath the two outspread doors, there is room for two trucks to park side by side, sheltered from the rain.

Level with each lorry is a pulley hoist driven electrically along rails towards the front end of the upper hold. If desired, they can be hooked together so as to be able to lift and carry a load of 3,300 lbs., each separately being capable of lifting 1,650 lbs. They raise goods at a rate of about 2 inches a second and travel at about 1 ft. 8 in. a second along the parallel rails.

Whilst loading or unloading is proceeding at the rear, a third lorry can be driven up to another loading door measuring 4 ft. 3 in. by 6 ft. 7 in. in the forward port side of the aircraft, giving access to the lower hold. A pulley hoist, identical with those on the upper deck, travels along a rail running spanwise across the lower hold. This rail has an extension which, braced against the sides of the fuselage, can be drawn out to reach over the platform of the lorry. A turntable enables the hoist to be transferred from the lateral to a longitudinal rail.

If the aircraft is not loaded from a lorry but directly from the ground, ramps can be used, two winches being provided for hauling up the goods. Each winch can pull 2,200 lbs. and can be anchored at various points of the hold so as to pull either from the front or the rear. A special feature of the Bréguet 761 for facilitating exceptional loading cases is that the rear part of the upper deck can be swung down so as to join on to the lower deck's ramp. If the operator wishes to load up very large articles which require the entire height of the fuselage, then this part of the upper floor can also be removed. This makes it possible to carry goods measuring up to 11 ft. 6 in. in height and weighing 9½ tons. In this particular instance, however, the aircraft has to be balanced by placing goods weighing between 2½ and 3 tons in the forward section.

On arrival at a terminal, the electrical equipment (hoists, winches) is connected via a special plug to a rotating current source of 220 volts and 50 c/s frequency. If the aircraft has to visit airports which have not been equipped accordingly, then an auxiliary generator of 10 kVA can be carried on board.



Model showing door in forward port fuselage with protruding rail for pulley hoist.

Whilst designing the aircraft so that it can carry a wide range of commodities and enable them to be loaded and unloaded with ease and rapidity, Bréguet engineers also bore in mind that the itineraries and length of the route sections also contribute largely towards satisfying the profit-conscious operator. Thus the flight deck of the Bréguet 761 has been arranged so that a reduced crew can be used for short laps over familiar routes where radio aids are available for navigation, or a complete crew for long distances over uncharted territories where a navigator has a full-time job. Its main particularity is that the co-pilot can also function as navigator and radio operator, in which case the controls before the starboard seat can be uncoupled and this seat, otherwise positioned next to the pilot's seat, slid rearwards. Still facing forward, the co-pilot can fold down a table for his maps, the navigation instruments being within easy reach. He can also swivel his seat so as to face the radio equipment mounted against the starboard side of the cockpit.

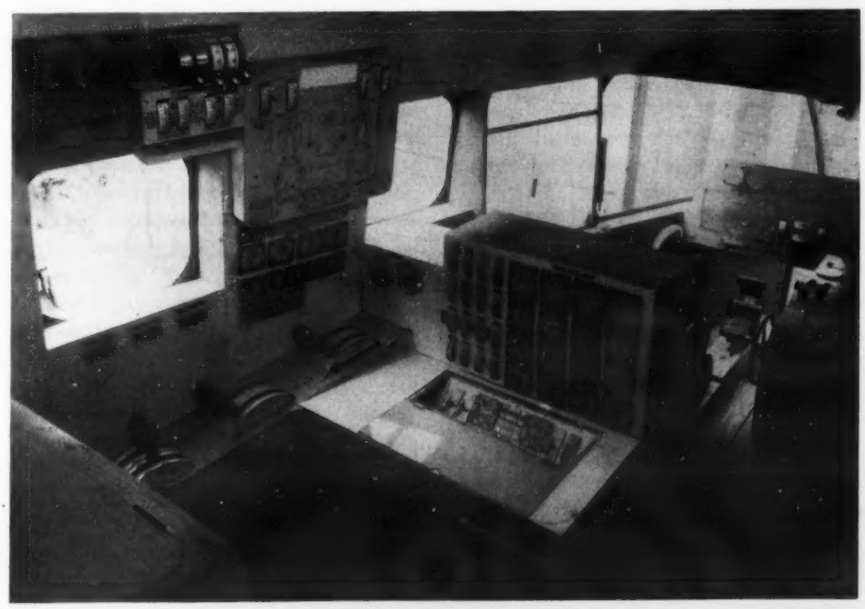
The flight engineer sits facing forwards, directly behind the pilot. All his instruments are conveniently grouped on a table before him, and he also has a clear view of the pilot's instrument panel. Side windows allow him to keep an eye on the engines without leaving his station. Behind him is an easily accessible compartment containing the automatic pilot equipment.

It should be mentioned that the Bréguet concern developed and built the model 761 in close collaboration with government civil aviation authorities and the technical department of the French Air Ministry. It is specified that the aircraft be delivered with a comfortable, sound-proofed, air-conditioned cabin for 8 to 44 passengers, in accordance with customers' wishes, on the upper and/or lower deck.

The smallest cabin, for eight passengers, is located in the forward part of the upper deck and separated from the flight deck by a small vestibule giving access to a lavatory and a luggage compartment.

In conclusion to this exposé on cargo transport aircraft design and equipment, it should be brought to mind that decreasing the price of transportation is not only of cardinal importance to the development of air cargo carriage, but it also helps to place air travel within the reach of the man in the street. In this respect, the Bréguet 761 " double-decker, " which can easily be fitted to accommodate some 90 passengers, i.e., slightly more than the capacity of a railway coach, means an important step forwards along the road to mass air travel.

Mock-up of flight deck : left, flight engineer's station ; in front of latter, pilot. The co-pilot, whose seat can be slid backwards if he is to function as navigator and radio operator, is normally stationed to the right of the pilot.



The wing of the Bréguet 761 has been derived directly from the Bréguet 730 four-engined flying-boat. The outer covering, reinforced with spanwise stiffeners, forms a torsion box with the two spar webs.

SPECIFICATIONS

MAIN DIMENSIONS

Span	136 ft. 8¼ in.
Length	94 ft. 2 in.
Height	31 ft. 3¼ in.

FUSELAGE

Upper Cargo Hold

Length	50 ft. 4¼ in.
Width	9 ft. ¾ in.
Height	7 ft. 2¾ in.
Floor area	452 sq. ft.
Volume	904 sq. ft.

Lower Cargo Hold

Length	45 ft. 1¼ in.
Width	9 ft. ¾ in.
Height	7 ft. 2¾ in.
Floor Area	323 sq. ft.
Volume	2,931 cu. ft.

Total Floor Area	775 sq. ft.
Total Cargo Volume	5,897 cu. ft.

Loading Doors

Main rear opening :	
Length of front doors	20 ft. 5 in.
Length of rear doors	14 ft. 9 in.
Forward port door	4 ft. 6 in × 6 ft. 6¾ in.
Two emergency exits above wing	1 ft. 5¾ in. × 3 ft. 7¼ in.

WING

Area	1,923.5 sq. ft.
Chord at root	16 ft. 10½ in.
Chord at tip	9 ft. 3½ in.
Thickness at centre-section	17% (at 30% chord)
Thickness of outer panel	17% to 11.6% (at 30% chord)
Aspect ratio	9.7

TAIL GROUP

Horizontal Assembly :

Span	45 ft. 6 in.
Stabilisor	303.5 sq. ft.
Elevator	147.5 sq. ft.
Total area	451.0 sq. ft.

Vertical Assembly :

Fin	2 × 60.06 sq. ft.
Rudder	2 × 43.06 sq. ft.
Total area	2 × 103.12 sq. ft.

UNDERCARRIAGE

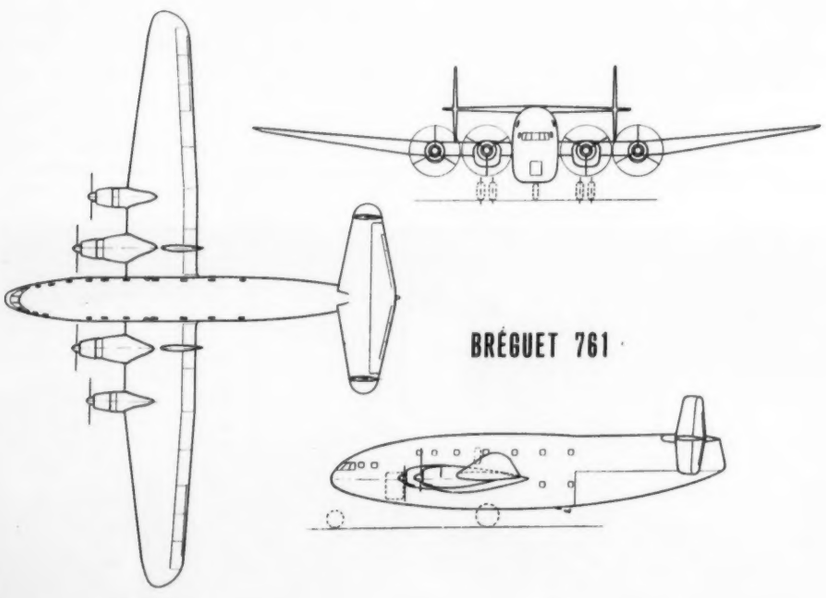
Track	24 ft. ¾ in.
Wheel base	36 ft. 3½ in.

Main Wheels :

Tyres	4 ft. 11 in × 1 ft. 9 in.
Strut stroke	1 ft. 7¾ in.

Nose-Wheel :

Tyres	3 ft. 7½ in. × 1 ft. 4½ in.
Strut stroke	1 ft. 7¾ in.



POWER PLANT

Four SNECMA (formerly Gnome & Rhône) 14 R 24 fourteen-cylinder twin-row radials driving Bréguet three-blade airscrews with Ratier pitch control.

Take-off power, each	1,568 H.P.
Rated power per engine at 10,000 ft.	1,130 H.P.
Airscrew diameter	12 ft. 5¾ in.

WEIGHTS

	Pure Cargo Version	Version with Cabin for 8 passengers
Tare weight with crew	48,610 lbs.	49,385 lbs.
Fuel and oil for 620 miles against 30 - m.p.h. head-wind and with reserve for 1 hr. cruising	6,505 lbs.	6,505 lbs.
Payload	28,665 lbs.	27,890 lbs.
Take-off weight	83,780 lbs.	83,780 lbs.
Wing loading	43.5 lb./sq. ft.	
Power loading	13.30 lb./H.P.	

PERFORMANCE (design)

Cruising speed at 10,000 ft. on 60% rated power	200 m.p.h.
Landing speed	83 m.p.h.
Range without payload against 30 - m.p.h. headwind and with fuel reserve for ½ hr.	2,980 miles

OPERATING COSTS

calculated according to U.S. Air Transport Association (ATA) methods for a distance of 620 miles (1,000 km), payload of 30,865 lbs. (14,000 kg) and an average cruising speed of 196 m.p.h. (315 km/h).

Assuming : Fuel price, 41.2 U.S. cents per Imp. Gall. Fuel consumption, 0.447 lb./H.P./hr. Oil price, 126.8 U.S. Cents per Imp. Gall. Oil consumption, 0.022 lb./H.P./hr. Other assumptions according to ATA formulæ.

Operating costs per hour

Fuel	$ 78.70
Oil	9.90
Airframe amortisation	29.20
Engine amortisation	12.38
Airframe maintenance	15.60
Engine maintenance	12.60
Ground service	11.70
Pilot's salary	10.50
Remaining crew's salary	10.33
Crew bonus	2.14
Aircraft insurance	18.56
	$ 211.61

Payload performances factor

Average cruising speed × payload = 2,690 ton. m.p.h.

Direct operating costs per ton-mile $ 0.078

The Sperry Microwave Instrument Landing System

By G. GUANELLA, Dipl. Eng., E.T.H., Zurich

In bad weather the final phase of a flight, i.e., the approach from almost unlimited air space to the narrow confines of a runway, calls for a high degree of efficiency both on the part of the pilot and his navigational instruments. Airline safety and regularity, and the traffic capacity with which airports have to cope, depend to a great extent on the efficacy of the instrument landing systems in operation.

Air navigation is confronted with problems comparable with those common to road and railway traffic control. When approaching an airport a pilot has to abide by orders issued from a central traffic control station. For instance, he may be instructed to take his place in an organised holding pattern and wait his turn before coming in to land along a prescribed approach leg, just as a locomotive driver is guided along his course through the medium of remote-controlled signals and shunts.

In this final phase of the flight, the pilot assumes the rôle of a servo mechanism which has to respond well nigh instantaneously to the slightest deviation from course and to all intelligence received ; assuring, therefore, that all operations relative to the prescribed landing procedure are carried out correctly. In principle, these functions can also be entrusted to an *ad hoc* automatic system which is not restricted in its efficiency to the limits of human power to react. In this case the pilot's duty is to watch and control, and be on the alert to intercede where and when necessary.

The approach and landing can be controlled by a *ground navigational aid*, in which instance a ground station follows the aircraft's movements and radios the pilot all necessary instructions for changing course. In the *ZZ System* for bad-weather approaches, the ground observers relied on repeated bearings and partly on their ability to judge engine noise. In the *GCA (Ground Controlled Approach)* system, however, the aircraft's position is constantly checked by modern radar equipment.[1] This system was operated with considerable success during the last years of the war, but its ground installations require a large number of servicing personnel and the ground/air transmission by radiotelephony means time delay and leaves room for error. Systems were therefore proposed, such as the PPI (Plan Position Indicator), for instance, in which an image is transmitted from the ground set directly to the aeroplane. In this way the pilot can observe his position alongside prominent landmarks at all times on a cathode-ray screen. Systems involving this principle include, for example, Navarscope [2] and Teleran [3]. Another feature is that insignificant parts of the image, such as aircraft flying at other altitudes, can be obliterated. It is also possible to supply complementary data on such subjects as altitude, wind velocity, etc.

If the aircraft carries *airborne aids to navigation*, the pilot is independent of any human or mechanical ground observations. In this case, the approach path is plotted out by stationary installations, enabling the pilot to perceive deviations from the prescribed approach course without having to take intermediate bearings from the ground. The most reliable aid to night landing is an efficient *runway lighting system* which, as shown in Fig. 1, is composed of rows of lighting units on either side of the approach lane and runway. According to his altitude and distance, the pilot will see the images represented in A, B, C, from which he can easily accomplish his approach.[4] Runway lighting is a valuable complement to the instrument landing procedure, and notably so when the aircraft is in immediate ground vicinity. Meanwhile, intense fog unfortunately reduces to a great extent the efficacy of any optical aid.

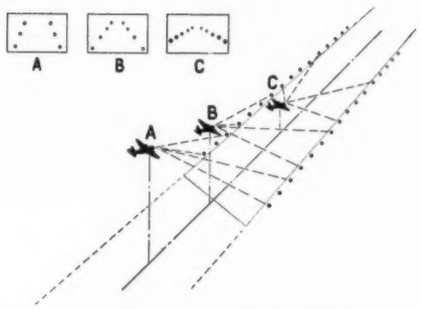


Fig. 1: Airport lights as aid to navigation.
A, B, C = runway as seen from approaching aircraft at different points.

The *FIDO* (Fog Investigation Dispersal Operation) System eliminates fog by means of open combustion of liquid fuels alongside the approach path and runway.[5] However, the exorbitant operating cost of such systems has stood in the way of any wide-spread introduction. Also proposed, therefore, has been the utilisation of *infra-red rays* in place of visible light, as these feature superior fog penetration characteristics. Still more effective are microwaves with wave lengths of 2 to 20 cm ; even in the densest fog, their

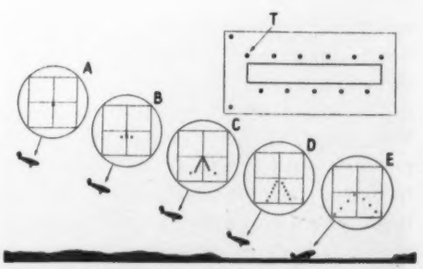


Fig. 2: Radar instrument landing.
T = Microwave transmitter.
A ... E = Cathode-ray presentation to approaching aircraft.

[1] " Interavia, Review of World Aviation, " March, 1947, P. 16-20. — " Electrical Communication, " Vol. 24, No. 1, P. 72-81. — " Bendix Radio Engineer, " January, 1946, P. 17-25.

[2] " Interavia, Review of World Aviation, " February, 1947, P. 38. — " Electrical Communication, " Vol. 23, No. 2, P. 121-135.

[3] " RCA Review, " Vol. VII, No. 4, P. 601-621 — " Electronics, " February, 1946, P. 124-127.

[4] " Interavia, Review of World Aviation, " March, 1947, P. 47-51.

[5] " Interavia, Review of World Aviation, " June, 1947, P. 43-46.

absorption and diffraction remain within permissible limits. Instead of lighting units, *microwave generator beacons* are installed along the edge of the field, which yield a pattern on the search scope similar to that formed by a conventional airport lighting system (Fig. 2). An advantage of this system is that it places no undue strain on the pilot ; flying with a luminous image as guide ought to be well within human possibilities and not require any special re-adaptation of the senses and power to react. Meanwhile, the system's installation is costly ; practical realisation is, moreover, difficult owing to the fact that the cathode ray presentation must have a high degree of luminosity.

It was also tried to show the pilot his deviations from the approach path by other means. In the *induction blind landing system*, numerous cables buried beneath the airfield (Fig. 3) carry a strong alternating current of

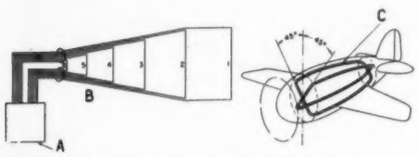


Fig. 3 : Induction blind landing system.

A = 500-cycle generator.
B = buried cables.
C = pick-up loops.

500 c/s. Tensions are induced by two crossed pick-up loops in the aircraft, the amplitudes or amplitude differences of which indicate deviations in azimuth or elevation. Notwithstanding interesting results obtained in tests, this system has been dropped for technical and financial reasons.

Of particular importance at present are the *beacon-type instrument landing systems*, in which the approach lane is characterised by high-frequency beams with axes approximately coincident with this lane. The vertical or localiser plane of the approach plane and, according to newest practice, the horizontal plane or glide path, are characterised by pairs of overlapping beams. In earlier European systems these beams were alternatively keyed to specified morse codes, to A-N, for example. As in the well-known airway beacon systems for long-distance flying, deviations off course are presented to the pilot in the form of a coded telegraphic signal. In the central plane of the two beams which coincides with the glide path, however, this signal becomes a continuous one owing to the amplitudes of the reception signals being equal.[6] In place of the morse-coding procedure, newer systems have adopted a method of amplitude modulation of the two beams at different audio frequencies, and a suitable indicator has been added to the audio control. Originally, the high-frequency waves featured a very feeble frequency, of 200-400 Kc/s. Undesirable errors owing to ground reflections and further disadvantages of long waves have since been minimised considerably by augmenting the frequency to about 100 Mc/s. In the *SCS-51 instrument landing system*, which gave valuable service in many theatres during the last war, mobile transmitters are used for radiating the localiser beam (approx. 110 Mc/s) and the glide path beam (approx. 330 Mc/s). Additionally, there are three marker beacons which emit an audio-modulated outer signal (approx. 400 c/s), middle signal (1,300 c/s) and boundary signal (3,000 c/s) on a 75-Mc/s carrier wave, thus signalling the main points along the approach lane.[7] In view of the good results obtained with this system, and its obvious utility to commercial airline operations, the SCS-51 or ILS (Instrument Landing System) as it is known in civil aviation circles, has been recommended by ICAO for general adoption for the time being. The U.S. Civil Aeronautics Administration ordered its installation throughout the entire U.S. domestic air network and it is already in operation under the name of CAA Instrument Landing System.[8] It is to be hoped that this measure will enable the U.S.A. to catch up with the European advance in airline traffic control, which has been using similar, though less perfected, instrument landing systems for years with great success and often under difficult conditions.

Meanwhile, development of guidance-beam instrument landing systems may in no way be considered as terminated. Currently-used frequencies are not yet an invariable proof against undesirable ground influences. Moreover, the antennae are fairly tall structures and constitute a hazard to aircraft. A thoroughly reliable system for measuring distances would seem more desirable than the present marker beacon transmitters for indicating the main points along an approach path. Most welcome would be a coupling of the entire procedure with the automatic pilot ; this would relieve the pilot and eliminate the possibility of human errors. And today the elements of microwave and radar technology necessary for executing this idea are sufficiently well advanced.

The Federal Telephone & Radio Corporation, of Newark, N.J., has developed a VHF system of this sort, which is known as *Navaglide*. This utilises the same frequency, but a microwave one, for the localiser and glide path beams ; the separate signals are distinguished by using different modulation frequencies, which lie above the audio-frequency range. The Navar distance-meter,[9] based on the pulse method, is used for ascertaining the aircraft's distance from the airport.

The Sperry Gyroscope Co. Inc., of Great Neck, N.J., has developed a *Microwave Instrument Landing System* which is already in the operational stage and has successfully passed numerous full-scale tests. Known under the abbreviation of MLS, it certainly indicates the road which future instrument landing technique must take. The following paragraphs contain a description of the system.

As in the ILS, the beams characterising the localiser and glide path planes are radiated from two *mobile transmitters* with built-in antennae. The antenna assembly of the glide path transmitter, visible in Fig. 4, consists of

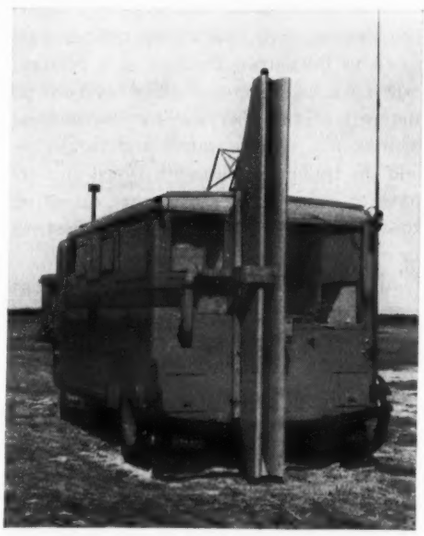


Fig. 4 : Mobile glide path transmitter.

Antenna assembly with parabolic reflector for radiating two glide path microwave beams. Theodolite visible inside trailer is for exact setting of glide path courses.

a narrow parabolic radiator, to which the high-frequency energy is supplied via two beam feeds of rectangular section ; the latter are disposed so as to produce two overlapping flat beams. Fig. 5 shows the equipotential surfaces of these beams, transmitted with the same carrier amplitude. A distinction can be made at the reception end by means of amplitude modulation at audio frequencies of 600 and 900 c/s. The waves are amplified and rectified by the airborne equipment, resulting in two low-frequency tensions of 600 and 900 c/s, the amplitudes of which coincide when the aircraft is in the glide path or intersecting plane of the two glide path beams. Any deviation in elevation from this plane will cause the reception amplitude of one or the other high-frequency waves to dominate. An instrument signals any corresponding difference in amplitude between the low-frequency tensions, thus

[6] " Interavia, Review of World Aviation, " July, 1947, P. 48-49.

[7] " Interavia, Review of World Aviation, " February, 1947, P. 39. — " Electrical Communication, " Vol. 22, No. 4, P. 262-294.

[8] " Interavia, Review of World Aviation, " Nov./Dec., 1946, P. 63-66. — " Electronics, " February, 1945, P. 116-124 and March, 1945, P. 128-135.

[9] " Interavia, Review of World Aviation, " February, 1947, P. 39. — " Electrical Communication, " Vol. 23, No. 2, P. 136-137.

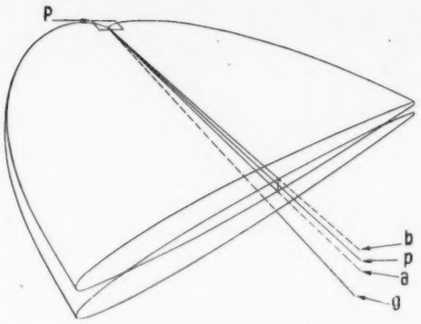


Fig. 5: Three-dimensional radiation pattern of glide path antennae.

P = Airport.
g = Ground line.
p = Glide path.
a, b = Axes of glide path beams.

enabling the pilot or automatic pilot to correct deviations accordingly. In this way, the aircraft flies along a fixed plane towards the runway and is virtually blocked between the two glide path beams.

A second transmitter working on a slightly different frequency radiates the beam for guiding the aircraft along the localiser path. Its main antenna assembly consists of a paraboloid reflector (Fig. 6). The high-frequency waves, again amplitude modulated at 600 and 900 c/s, are fed into the radiator to the left and right of the focal point, so that two adjacent funnel-shaped beams with a vertical central plane result. The already-mentioned method of amplitude comparison

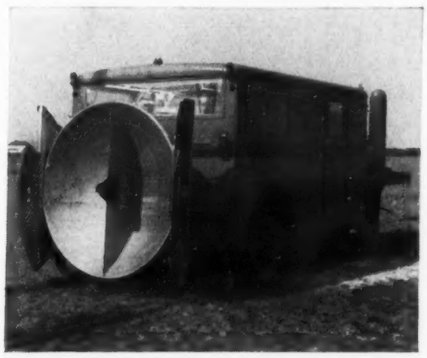


Fig. 6: Mobile localiser transmitter.
Main antenna (centre) with paraboloid for radiating two main beams. Auxiliary antennae for side coverage. Visible inside trailer is theodolite for setting localiser plane.

is used to guide the aircraft along this plane, otherwise known as the localiser path. On either side of the main antenna are two smaller parabolae, which transmit two side beams into space in order to widen the coverage and make it easy for the pilot to pick up the signals.

Fig. 7 shows how the two transmitter units are set up. Logically enough, the glide path transmitter is positioned slightly to the side of the runway, though this is not very important to glide path reception in view of the wide beam characteristic.

Figs. 8 and 9 are radiation patterns of the two transmitters. At angles of ± 15 deg. on either side of the course the two glide path beams still feature half maximum power, maximum being in course direction. Taken perpendicular to the course axis, however, the half-value width is only ± 1.1 deg. By setting the antenna accordingly, the glide path elevation angle, A, can be set freely to suit the particularities of an incoming aeroplane. On the other hand, the two main localiser beams have a half-value width of ± 4 deg., and the auxiliary localiser beams, one of ± 15 deg. ; vertically, there is a strong beam concentration within ± 2-deg. limits. At low frequencies, of course, such radiation patterns could not be achieved without extremely large antenna assemblies, so large that they could scarcely be built. Antennae which are too small would produce insufficient beam concentration and, consequently, an insufficient degree of accuracy, this apart from the formation of undesirable auxiliary beams resulting in erroneous signals and eventual disasters. Meanwhile, microwaves are also a means towards fulfillment of various other requirements of a wholly reliable instrument landing system. As is known, their frequency range is almost completely free from parasites ; frequency distribution is extremely simple, on the one hand because of the great number of available bands, on the other because the waves are not refracted and consequently enable the same frequencies to be utilised at differents points. Currently, carrier frequencies of approx. 2,700 Mc/s (wave lengths of about 11 cm) are being applied ; but an increase to approx. 5,000 Mc/s (6 cm) is foreseen. It is difficult to imagine still higher frequencies being used, owing to the influences of rain and fog on shorter waves.

In Fig. 10 may be seen the equipment carried in the two mobile transmitters. A transmitter frequency multiplier increases the frequency of a quarz oscillator through stages from approx. 5 Mc/s to approx. 270 Mc/s, the output amplitude being regulated automatically so as to remain constant. A three-stage klystron amplifier is used for further multiplication to approx. 2,700 Mc/s and for furnishing an output energy of 70-700 watts. Other racks visible contain the rectifiers and tension stabilisers for the different units of the equipment. A gasoline-driven generator serves as primary power source.

The klystron amplifier (Fig. 11) comprises a multiplier stage, a buffer stage, and a final

Fig. 10: Transmission equipment of MLS.

Left below = Rectifier for frequency multiplier.
Left centre = Quartz oscillator and multi-stage frequency multiplier.
Left above = Klystron frequency multiplier and output stage.
Centre = Transmitter control station.
Right = Rectifiers and tension regulators.

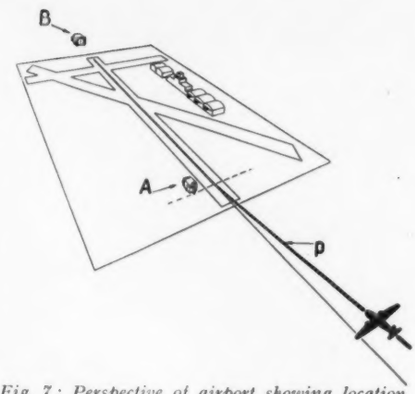


Fig. 7: Perspective of airport showing location of localiser and glide path transmitters.

A = Glide path transmitter.
B = Localiser transmitter.
p = Glide path.

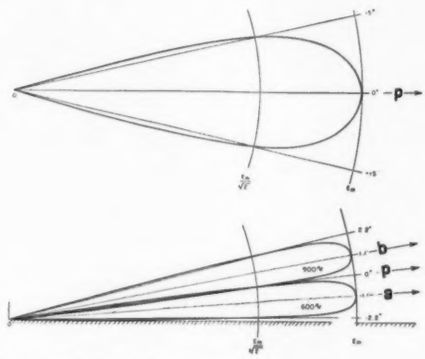


Fig. 8: Glide path antenna pattern.

p = Course.
a = Lower beam axis.
b = Upper beam axis.

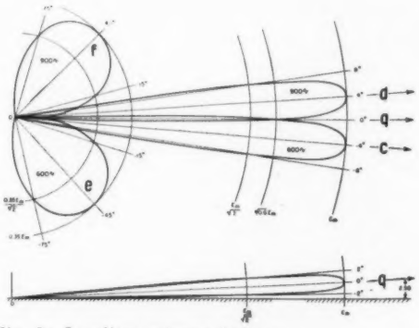
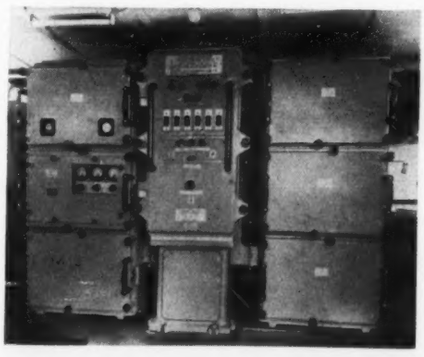


Fig. 9: Localiser antenna pattern.

q = Course.
c = Left main beam axis.
d = Right main beam axis.
e = Left auxiliary beam axis.
f = Right auxiliary beam axis.



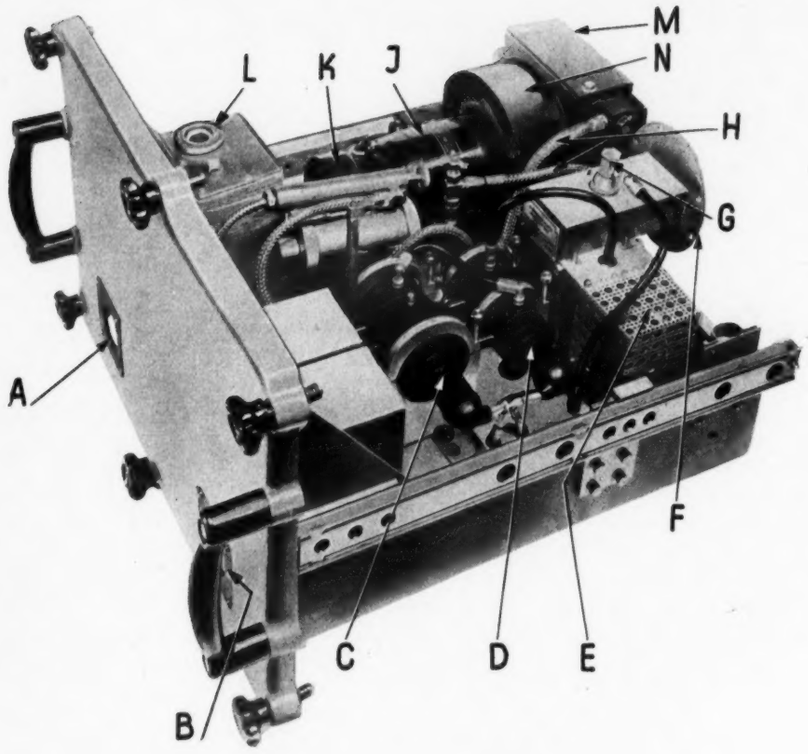


Fig. 11: Klystron amplifier

A = Microwave output indicator.
B = Coolant temperature indicator.
C = Multiplier klystron.
D = Buffer amplifier klystron.
E = Final klystron amplifier.
F = Wave guide starting section.
G = Thermocouple pickup.
H = Coolant lines.
J = Motor.
K = Coolant pump.
L = Coolant reservoir.
M = Radiator.
N = Fan.

stage. The three tubes are liquid-cooled and accurately temperature-regulated from 85 to 1 deg. Fig. 5 shows a front view and a section of the multiplier klystron. Rotating metal paddles extending into the resonant chambers provide an exact means of setting the operational frequency in the ± 15 Mc/s range.

These tubes constitute a vital organ of the entire equipment and contribute in a large measure towards the efficiency of an instrument landing system. In view of the fact that, contrary to pulse-radio goniometers and conventional radar systems, continuous carrier energy is used instead of short pulses, no application has been made of magnetrons because these are more suited for generating short bursts of energy and, as independently-oscillating generators, they have the disadvantage of producing very inconstant frequencies.

Both the glide path and localiser transmitters are equipped with several quartz

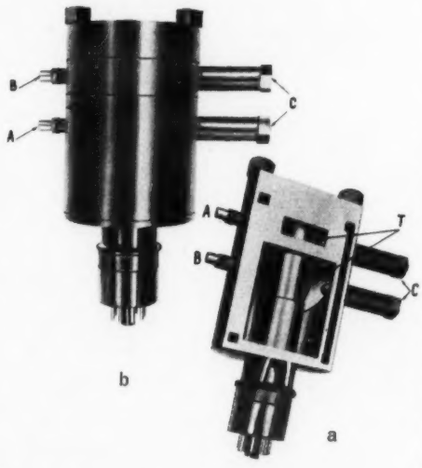


Fig. 12: Frequency multiplier klystron.

a = Section; *b* = Front view.
A = Input, 270 Mc/s.
B = Output, 2,700 Mc/s.
C = Tuning nuts.
D = Tuning paddles.

crystals which enable fixed transmission frequencies in intervals of 0.5 Mc/s to be selected. The crystal is stabilised to within ± 15 c/s (± .0003 per cent), i.e. ± 8,000 c/s after multiplication, of its rating by enclosing it in an automatically-controlled temperature oven. This frequency stability in conjunction with the very small bandwidth of the modulated transmission signal make it necessary to reserve only a very feeble frequency range for each transmission channel. In consequence, the reception bandwidth can also be kept small (250 Kc/s), so that the operation is extremely free from disturbances. Compared with navigation equipment based on pulse generation, this characteristic is a great advantage: short high-frequency pulses, such as those utilised for duration measurement in radar sets and pulse goniometers, for example, require very large bandwidths, up to about 10 Mc/s, owing to the necessarily very accentuated pulsation slopes.

(To be concluded next month.)

Filling a Vital Gap....

The Cunliffe-Owen CONCORDIA — *now in production* — fills that vital gap between the high-capacity long-distance airliner and the small feeder-type aircraft.

Its 10-12 passenger capacity (with adequate luggage allowance) makes it the right aircraft for the shorter and medium distance hauls up to 1000 miles, where the large airliner would be unprofitable and the smaller aircraft offers insufficient passenger accommodation to meet traffic requirements.

The CONCORDIA gives passenger comfort and luxury equal to that of the larger airliners — and, incidentally, smoking is permitted.

Operating either as a wholly passenger or part passenger-freight or in its full freighter version, the CONCORDIA will prove a dividend-paying proposition to operators on scheduled routes, charter services or cargo lines.

CONCORDIA

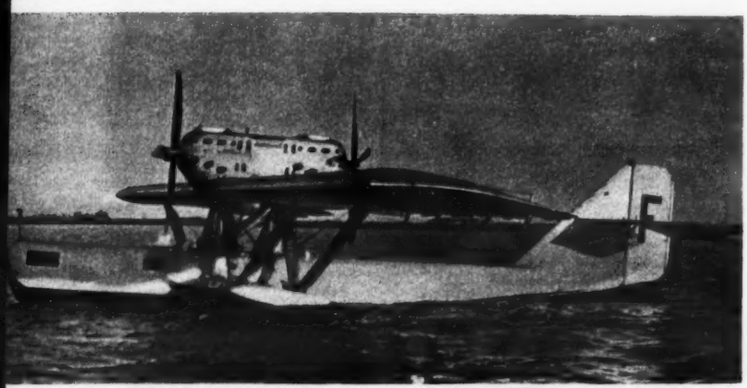
10-12 SEATER

CUNLIFFE-OWEN AIRCRAFT LTD
THE AIRPORT, SOUTHAMPTON, ENGLAND

Large Flying-Boats

by Marcel Moine, Paris.

By no means has the last word in the landplane vs. flying-boat controversy yet been pronounced. Apart from certain serious arguments in favour of the operation of one or the other type, are those dictated by personal or group interests. The following article by Marcel Moine, former head of the French Latécoère aircraft manufacturing concern, is not published in order to interrupt discussions of organisational nature, or to take sides with one or the other party in this controversy, but solely with a view to giving the floor to an expert whose opinions are backed by many years of experience in the development of Latécoère flying-boats. Marcel Moine left his firm in 1946, after having played a leading part for nearly 30 years in the design of French flying-boats and, as Technical Director, having been responsible for their realisation since 1930. It is not of primary significance if every reader is not entirely in agreement with the author's conclusions. What is important is that the opinions, observations and experiences of such an eminent flying-boat expert be heard. *The Editor.*



1927 : *Latécoère 32.0*, all-wood flying-boat of 16,500 lbs. for medium ranges.

1930 : 8-ton *Latécoère 38.0* (development of Latécoère 32.0) for medium-range passenger and mail carriage.

Latécoère 24, 1927, was predecessor of trans-Atlantic flying-boats (wooden construction ; 27,500 lbs. gross weight).

Technical Development and Commercial Operation of Flying-Boats.

Circumstances dictated that civil air transport history should find its beginnings in landplanes. It was 1918, and the war had fostered the development of landplanes to an incomparably greater extent than flying-boats. Whilst flying-boat pilots were rare, there was a surplus of landplane crews. In those days air services were routed over land, occasionally passing over narrow straits or small bays.

Major accidents, however, lost little time in revealing the hazards to which landplane services were exposed whilst over water, notwithstanding the fact that these services were routed over land to as great an extent as possible. For instance, landplanes crashed into the sea near Cap Creux, and the victims were washed ashore around Port-Vendres ; a little later, similar catastrophes occurred over the Straits of Gibraltar.

The logical idea which followed was to increase the number of engines as, indeed, engine trouble was the most frequent cause of accidents. After a few doleful experiences it was realised that this solution was altogether inadequate. Multiplying the engines contributed nothing towards the safety of landplane operations over water. It did, however, help to increase the regularity of overland air services.

For example, passenger services from Barcelona to the Balearic Islands, Alicante to Oran, or Marseilles to Algiers, called for aircraft which could not only take off from smooth water but, should the occasion arise, also be able to land on a fairly heavy sea. This was a primitive factor of flying safety, in the absence of which it was quite useless to expect customers.

Thus it came about that the Latécoère concern began studying and building flying-boats capable of fulfilling the requirements of air services then planned between France and Africa or America.

This decision dates back to 1933, at which time wood was the most commonly-used constructional material for flying-boats. Aluminium alloys were altogether too easily corroded by the salty air, and there was no really efficient protective coating available at that time. Thus the *Latécoère 32.0* flying-boat, the first to be used on the regular Marseilles—Algiers route, was built of wood. It was a high-wing monoplane powered with two engines arranged in tandem. The wing-struts were borne by two stub-wings positioned on either side of the hull. These fulfilled a three-fold duty. They served as hydrostatic and hydrodynamic stabilisers whilst the aircraft was resting on the water ; as fuel tanks, reducing fire hazard because of their being outside the hull ; and as auxiliary lifting surfaces during flight. Their aerodynamic significance was only slight, but they all the same contributed a little towards the aircraft's flight characteristics.

Weighing 16,500 lbs. fully loaded, the Latécoère 32.0 was considered to be a very large aircraft for its day.

The *Latécoère 38.0*, completed in 1930, was a metal version of the model 32.0. The duraluminium hull and floats bore protective coating of Jirotka and linseed-oil paint ; the fabric-covered wings had metal spars and struts.

By this time, operators had decided to venture beyond the Mediterranean. The Société Latécoère was fully intent on starting South-Atlantic air services, and a prototype suitable for this purpose was built in 1927. This was the *Latécoère 24*, another wooden flying-boat, but with a silhouette which bore witness to an effort on the part of the designers to obtain an aerodynamically-clean flying-boat. Their efforts did indeed bear fruit, but unfortunately at the penalty of manoeuvrability during take-offs and landings. The flight tests were thoroughly discouraging, and

left no alternative but to alter the design of the empennage and hull completely. Thoug it revealed a range of about 2,000 miles against a 30-m.p.h. headwind, the Latécoère 24 required a pilot of exceptional skill for the take-off. The model 24, as it stood, was a failure ; and our next step was to subject the hull dimensions to a thorough examination.

For this purpose, we chose the test tank at Banlève, belonging to the Ministry of Public Works, which was quite suitable for testing hulls once the overhead conveyer had been modified.

Our unsuccessful model 24 was reborn in 1932. As a matter of fact, it was the *Latécoère 300 "Croix du Sud"* which emerged, an all-metal flying-boat weighing 24 ½ tons fully loaded, possessing a cruising speed of 105 m.p.h., and capable of providing safe transportation over the South Atlantic between Dakar and Natal. The enormous increase in tonnage in order to achieve the desired aerodynamic and hydrodynamic characteristics was just one of the costs which had to be borne in view of the level of science at that time.

A series of flying-boats derived from this prototype were operated between Africa and America, replacing the packet boats used for transporting mail and passengers. Later on, their place was taken by faster Farman four-engined airliners.

Despite its weight of 24 ½ tons, however, the performance of the Latécoère 300 was unsatisfactory. It was uncomfortable and useful volume was restricted. Once again, we began searching for new designs and constructional materials.

The *Latécoère 300*, a test model of smaller tonnage, revealed an excellent performance but, because of its very light construction, was of little commercial value.

Continuing along purely theoretical lines, we came to the conclusion that a passenger aircraft capable of spanning the South Atlantic (2,000 miles) on a commercial basis, should also be suitable for mail delivery across the North Atlantic (3,700 miles). In 1935 our theoretical studies gave birth to the project and later the prototype of the *Latécoère 521 "Lieutenant de Vaisseau Paris."*

Construction and external form remained the same : metal hull with stubs supporting the wing-struts ; wing of composite construction (metal framework with fabric skin). This time, however, the gross weight of the South-Atlantic flying-boat had risen to 36 ½ tons, and that of the North-Atlantic type to 41 tons. Cruising speeds were between 110 and 125 m.p.h.

This design of flying-boat fulfilled perfectly all that was expected of it. It effected many North-Atlantic crossings, competed successfully with the U. S. Boeing types and held, for a long time, the record for the non-stop New York—Biscarosse run. Meanwhile, its speed was still insufficient. Operators wanted still higher performance. A refinement of the airframe could only be obtained by eliminating the floats and wing-struts. We had already built a type with a cantilever wing and stressed skin, the *Latécoère 298*, but its design principles could not be transferred to an aircraft with a wing span of 125 ft. or more, before the strength calculations had been verified in numerous trials and material tests.

Elimination of the stub-wings called for a return to lateral floats, as the displacement tonnage of the hull was insufficient to guarantee lateral stability. Again, these floats represented additional drag, which was not to be underestimated and could only be overcome by having them retract into the engine nacelles.

A further design had already left the drawing-board stage when political circumstances necessitated a cancellation of all civil development work. It was 1938 and war clouds were becoming increasingly menacing. We had to concentrate our efforts on military types and modify our plans so as to provide the Navy with patrol and troop-transport flying-boats. Our efforts were crowned with the completion of the prototype *Latécoère 611 "Achernar,"* which is still in service today. Production of this flying-boat was started at the end of 1939, but interrupted by the Fall of France in 1940. We are convinced that, if it were fitted with up-to-date reciprocating engines or gas turbines, the model 611 could still meet the requirements of the French Navy. It would probably be difficult matter to reduce the drag of a military flying-boat still further. The Latécoère 611 is a cantilever monoplane with stressed skin and retractable floats, and its empennage has been designed on the basis of particularly thorough aerodynamic studies. The rudders feature extremely small dimensions and the attachment to the fuselage of the tail-plane, with upward dihedral, reduces tail turbulance to a minimum. The Latécoère 611 weighed 29 ½ tons and could cover 2,800 miles non-stop, carrying its full military load

In 1940, a few months after the Fall of France, work was resumed on commercial types. The valuable experience gained with the Latécoère 611 could now be incorporated. The first result was the six-engined *Latécoère 631*, weighing 165,000 lbs., which was part of the heavy flying-boat programme established by the authorities. The prototype, begun in 1940, undertook its maiden flight in October, 1942. The Germans confiscated it in February, 1944, but lost it a few weeks later, during an Allied air raid over Lake Constance. The second prototype was dismantled immediately after completion, in order to conceal the parts from the Nazis and to protect them against aerial bombardments. It was re-assembled and transferred to Biscarosse again in October, 1944. On March 15th, 1945, it was ready to take the air, and at the beginning of March, 1945, was flown from Biscarosse to Dakar and back.

In September it was officially christened *"Lionel de Marmier"* and, under that name, has been flying the regular Biscarosse—Buenos Aires service since that date, despite a much publicised accident of which the consequences were less serious than is generally believed. (A propeller spinner breakage caused two blades to tear loose and rip through the cabin ; two passengers were fatally injured, the fuselage spars were damaged and the servo-pressure controls severed.)

Technical and Commercial Advantages of Heavy Flying-Boats in Future Civil Air Transport.

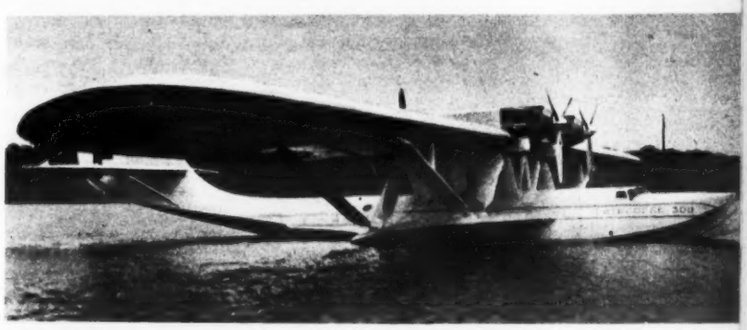
Increases in the gross weight of flying-boats are accompanied by superior aerodynamic qualities and passenger comfort. They become less susceptible to atmospheric turbulence, with the logical result that accommodation is greatly improved.

Wind-tunnel tests have revealed a lift-drag ratio of over 20 for the *projected Latécoère 185, a 170-ton flying-boat*, and there is every reason to believe that this will increase to 21 during the flight trials.

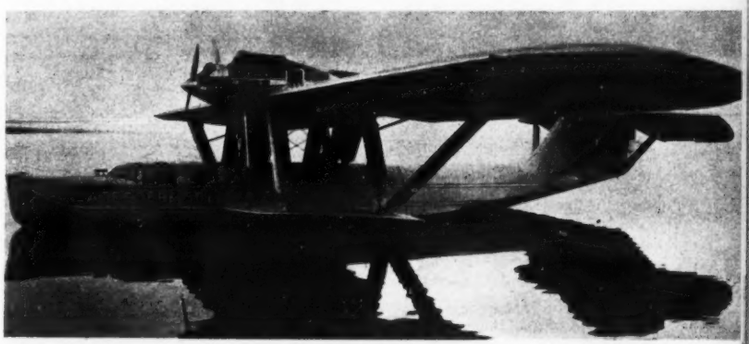
A flying-boat of this type would be able to transport 150 passengers from France to the U. S. A. and be more confortably equipped than the "Lionel de Marmier" : bar, dining room, cabins on two floors, corridors extending the length of each floor, with communication stairways at both ends.

It would cover 3,700 miles at a cruising speed of 325 m.p.h. against a 35-m.p.h. headwind, all the time maintaining between 3,000 and 10,000 ft. altitude. Incidentally, a flying-boat is just as capable of stratospheric operations as a landplane. Just as in the case of landplanes, however, there is a current lack of suitable power plants, such as turbo-jets and prop-jets, and of pressurisation equipment. An efficient sealing of the lower hull has already been achieved, and it would probably not be difficult to do the same for the upper part of the airframe.

On the other hand, every weight increase in landplanes involves new difficulties in the design of retractable undercarriages.



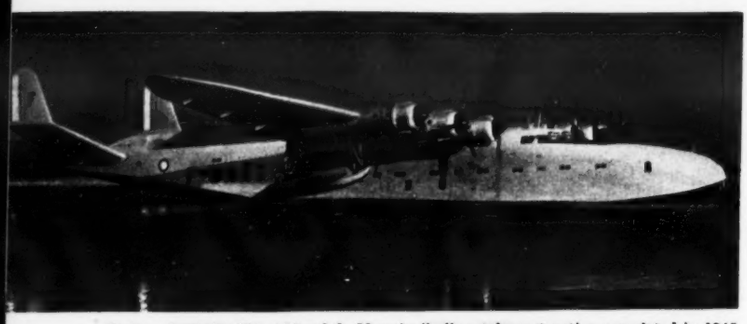
Latécoère 300 "Croix du Sud," **all-metal 24 ½-ton flying-boat, completed in 1932 and operated over South Atlantic (2,000 miles).**



1934 : ***Latécoère 500,*** **all-metal, weighing 21,000 lbs. ; fuel tanks in wing-stub range of 3,000 miles.**

South-Atlantic version of *Latécoère 521 "Lieutenant de Vaisseau Paris"* (1935) weighed 36 ½ tons ; North-Atlantic type, 41 tons. Metal construction with fabric-covered wing.

Latécoère 611 "Achernar," Naval all-metal flying-boat completed in 1938; weighed 30 tons; range, 2,800 miles.



Today : Latécoère 631 "Lionel de Marmier," all-metal construction completed in 1945 and since then on scheduled South-Atlantic service. Gross weight, 74 tons; range against 35-m.p.h. headwind, 3,700 miles.

Latécoère 523 Navy flying-boat built in 1938; gross weight, 41 tons.

Present-day tyres are capable of withstanding pressures of 2 to 3 lb./sq. ft., but these loads can only be applied provided there is a runway capable of sustaining corresponding landing shocks.

On this count, flying-boats possess unlimited possibilites, as the strain on the hull, at equal take-off and landing speeds, is the same whether the flying-boat weighs 50 or 500 tons. Only the dimensions change. But in this respect, too, the heavy flying-boat possesses a marked advantage as, according to the law of Froude, which has hitherto not been refuted, the maximum amount by which the surface pressure on a hull may increase at the take-off is the cube of the linear dimensions. It is evident that it will never be as high as the impact pressure during the landing.

Accordingly, it is probable that future heavy flying-boats will incorporate smaller hydrodynamic areas, whereas landplane designers will be faced with increasing difficulties as regards undercarriage retraction.

As, from the technical standpoint, a flying-boat of 75 tons is on a level with a landplane of the same gross weight, the heavier flying-boat of the future is bound to be superior to the corresponding landplane.

Certain civil aviation experts maintain that it is not always possible to acquire sufficient freight orders to fill the considerable volume offered by flying-boats. They prefer, therefore, to carry smaller loads and intensify their schedules. In view of present-day circumstances, their reasoning is probably well founded. But they overlook the general trend of air transportation, and the possibility that, later on, the demand for freight transport may exceed the available volume. The development of civil aviation is at present hindered by the high cost prices, a shortage of material, and particularly by a poor guarantee of safety. In our opinion, the last-mentioned condition is the most important one; but the current conception of trans-ocean flying with multi-engined aircraft makes little or no allowance for passenger safety in the case of emergency landings.

There is no doubt that modern aero engines are extremely reliable and that careful maintenance and the relatively small strain imposed on them during flight practically precludes accidents. This probability calculation is also confirmed by accident statistics. Meanwhile, however, there always remains the possibility of an emergency landing owing to unforeseen causes, such as a leakage in a fuel tank, serious wing icing, lightning, or even the failure of an important part of the airframe.

The outlook for a landplane which has to make an emergency landing on water is by no means bright. It is a miracle if it does not sink with all hands on board. Passengers and crew can consider themselves lucky it they are saved, for the sharks in the South Atlantic and the icy temperature of the North Atlantic are likely to supply any missing details to the finale. These are all risks which have to be accepted in time of war, but it is hardly fair to risk paying-passengers' lives in this manner. At all events, the aeroplane itself is a complete loss.

A modern flying-boat, especially one with a well-built hull incorporating numerous watertight bulkheads and a keelson, is capable of withstanding a heavy sea without sinking. The disappearance of Mermoz with the "Croix du Sud" (probably owing to a failure in the crankcase), and the accidents involving a number of British and U. S. flying-boats, cannot be regarded as points against this argument, as those particular flying-boats did not feature the water-tight bulkheads contained in present-day constructions.

It has often happened that flying-boats have made emergency landings and been abandoned, and have been found floating many miles away from where they crashed, despite fairly heavy seas.

It is interesting to recall the case of the Latécoère 523, a military flying-boat which, during the last war, was forced to make emergency landing near Brest during a storm, and was abandoned by order of the captain. Despite serious damage caused by battleships brushing with it owing to stormy weather, it floated around for several days until it was finally necessary to send it to the bottom with shell fire. There was also the incident of the Latécoère 521 "Lieutenant de Vaisseau Paris," which rammed and sank two fishing boats whilst taking off from Le Havre. Although one of the bulkhead compartments and a float had been cut open, allowing water to enter, the flying-boat remained afloat.

Experience has shown that heavy flying-boats are in a position to guarantee those safety factors on water which landplanes cannot hope to supply. For this reason, flying-boats represent the safest means of air transportation on overseas and coastal routes.

One of the strong objections to the utilisation of heavy flying-boats is that the costs of maintenance and ground organisation are too high.

This question has been discussed at great length from the theoretical standpoint. In our opinion, it ought to be examined more closely in the light of practical experience. We are convinced that these estimated costs are exaggerated. All that a flying-boat base needs, we consider, is a slip for hauling the aircraft out of the water when necessary. For commercial operations, it is usually sufficient to moor the flying-boat to buoy. A small motor-boat can be used for carrying water, oil and fuel, as well as any necessary overhaul equipment, and can simultaneously serve to transport passengers, crew and freight from and to the shore. Such equipment has always sufficed for British flying-boat services, and these have never given cause for complaint.

It is scarcely to be imagined that beaching gear could cost more than a hard-surface runway capable of withstanding pressures up to 700 lb./sq. ft. (As far as we know, there are only two such runways in France : Orly and Marignane.) Moreover, it is impossible to believe that the cost of maintaining a flying-boat base could be greater than that of maintaining concrete runways and supplying tractors, fuel trucks, pumps and all the other installations which are indispensable to modern heavy landplane operations. The surface of a runway is very susceptible to damage by water ; the foundations are liable to sink and cave in. Provided it is well situated, a flying base is always in good operational condition. French coasts are sufficiently long and there are plenty of bays and sheltered estuaries suitable for flying-boat take-offs and landings.

We can safely leave the choice of suitable marine air bases to the people who are more acquainted with the economic problems of civil aviation. We would just like to mention that Paris need not be the terminal for all routes from the U. S. A. to France. As proof is the fact that 75 per cent of Argentine and Brazilian passengers flown by British flying-boats to Biscarosse, take the train in Bordeaux in order to go to Geneva, Marseilles and Nice, as well as to Paris. Only 25 per cent continue their flying-boat trip as far as London.

We do not mean to go so far as to say that the bay at Biscarosse must absolutely remain as terminal of all future Atlantic flying-boat services. It is, however, indubitably the most suitable test base available in France today.

The character of civil aviation is, above all, international. The great trunk routes from North and South America to Europe need not necessarily all lead to Paris. As, for most passengers, France is only a stepping-stone, it is quite unnecessary that the terminal be Paris. Most important is that it should simultaneously have connections with the main European network.

Our coasts are dotted with ports which might have been specially created for trans-Atlantic air routes. (Le Havre in the north and Marseilles in the south are particularly suitable. Modifications will necessitate some expense, but will certainly prove their worth.) Already today, the heavy flying-boat has aerodynamic qualities which are just as good as those of the landplane ; and they can be improved by increasing the tonnage. Flying-boats offer more space and greater comfort and, on overseas routes, will always provide greater safety than landplanes. It is difficult to justify the doubts which exist as to whether flying-boats should or should not be utilised.

One day, we shall to turn again to the construction of heavy flying-boats in France, at present sorely neglected. We can but hope that, at the moment we do resume this work, we will not have lost too much of the advance we had at the time of the Liberation.

The Air Hostess Told Us ...

Complaints Department

Our favourite air hostess says she has a mind to imitate the big department stores like Macy's in New York — "the largest in the world," according to the advertisement — and Selfridge's in London, not to mention the "Grand Passage" in Geneva ! She wants to open a Complaints Department. This would have two sections : a passenger vs. airline section and an airline vs. passenger section.

The airlines' official motto claims that "the passenger is always right." But don't think for a moment, Esmeralda says, that the airlines are *convinced* that their passengers are all delightful, well-bred boys and girls. The reason for the slogan is the fact that our modern world would hardly notice the absence of any one airline company, whilst any airline would certainly notice the absence of its patrons. Whilst the passenger may be "always right," he can't prevent the airline from hating his guts on occasions, in private. Just as the passenger sometimes hates the airlines, in public.

Those detestable passengers...

Esmeralda says that some passengers believe they may make themselves objectionable simply because they or their employers can afford to pay for the ticket. She wonders if the same people would also misbehave in any other means of transportation merely because they are flush enough to pay for the ride.

There was the case of elderly Baron X, Esmeralda reports, who flew from Geneva to Brussels the other day, apparently in order to prove his unexcelled nuisance value. He began his demonstration right at the terminal, immediately after the weighing of his luggage. He, too, wanted to be weighed-in, like a prize-fighter. He elbowed his way to the coach and out again at the airport. He pushed himself through the Customs, crashed through his co-passengers, shot aboard the aircraft to grab the best seat. When the other passengers got to the aeroplane, they found him and the air hostess on all fours looking for his monocle. Ten minutes later he produced a spare piece of glass and screwed it under his eyebrow. As soon as the aircraft was aloft, he began to undress, took off his coat and tie, got up, sat down, marched up and down the aisle for most of the two hour-plus trip to Brussels, thereby contributing to the *summum bonum* of the hard-working air hostess and her paying fellow-sufferers. In Brussels he jumped off almost before the aircraft stopped, marched into the Customs office like a Leader of Men, monopolized the customs inspectors. The hostess then arrived perspiringly to hand him No. 1 monocle ; he condescendingly pocketed it, and departed. No sooner had he gone that it was discovered that he had left his briefcase behind.

Our favourite hostess says she meets such types more often than you'd imagine. If they are not merely bothersome, they may have wolfish tendencies. Or they may be stubborn and go on smoking during the approach for a landing, or refuse to secure their seat straps at the take-off.

The hostess of the P. A. A. Constellation Clipper "Mayflower" must have had a hectic time on July 23rd when a crowd of seamen started a fight in the air somewhere between Calcutta and Karachi and could be calmed only after one of the participants had been bound and gagged by the crew. Then there was the kite-full of bedlamites being deported to Europe on August 5th in a Douglas DC-4 of the U. S. Flying Tiger Line. They must have presented a pretty problem to their woman attendant, Dr. Helen Anderson, although the prettiness of the "problem" seems to have been considerably embellished by the Flying Tigers' active public relations expert.

You see, the passenger is *always* right. Nevertheless, Esmeralda sometimes wishes that some of her passengers emulated Sydney Skolsky, the Hollywood movie producer, who intensely dislikes air travel. Whenever this Mr. Skolsky has to rush off to New York, he orders his doctor to give him a mild anaesthetic which makes him sleep for fourteen hours.

Those shocking airlines...

Being an objective person who likes to give everybody a hearing, Esmeralda agrees that passenger complaints are justified more often than they should be. Many of them concern the irregularity of the scheduled services. One recent example is that of a British airline operating a service from London to Prague, amongst others. Passengers had to wait eight hours before the aircraft left London — eight hours on a summer day ! To crown it all, the aircraft developed mechanical trouble after leaving London and had to turn back ... On July 29th, an Irish airline flying between London and Dublin left for Ireland, seventy-two hours late ... On July 25th an American company operating between New York and London (*not* American Overseas Airlines) established a new kind of timetable : Shortly after midnight, passengers waiting in London to fly to New York were told that the airliner was leaving in 30 minutes — at 12.30 a.m. a "mechanical defect" developed — at 2 a.m. the departure was announced for three o'clock — at 3 a.m. this was postponed until five — at 5 a.m a further delay until 6.15 was announced — at 6.15 the passengers learned that the aircraft would leave at 11.30, because of "bad weather" elsewhere. The aircraft left at 12.15 p.m. after men, women and children had spent the night and morning on chairs and on the floor in the airport lobby. There ought to be a law !

Smaller grouses are often just as irritating. You know all about the complicated international Customs annoyances, for which, it is true, the airlines are not to blame. Well, on July 28th a Douglas DC-6 landed in Paris, but for some unexplained reason the Boys in Blue had walked off before its arrival. There was no customs inspection — everybody felt something was nice and abnormal. It just shows you.

Why are passengers in America told that their ticket costs a certain amount of money, if subsequently they have to discover that they must pay an additional 15-percent transportation tax ? Why do they have to pay a dollar, plus fifteen cents tax, merely to get from city to airport and another $ 1.15 for the trip from airport to city at the other end ? The railway ticket takes you from the centre of one town to the centre of the next ! Why has a British airline abolished free lunches in the air and substituted a charge of five shillings for an uninspiring lunch-box ? Why does a Swiss airline charge you for the very smallest thing you consume, e.g., for a cup of coffee ? Our favourite air hostess says, perhaps the management has read that an estimated 560,000 gallons of coffee are going to be drunk in the air on the American domestic air routes in 1947. You see, this would provide about 14,130,000 cups of coffee, or, at 10 cents a cup, about 1,400,000 dollars in one year.

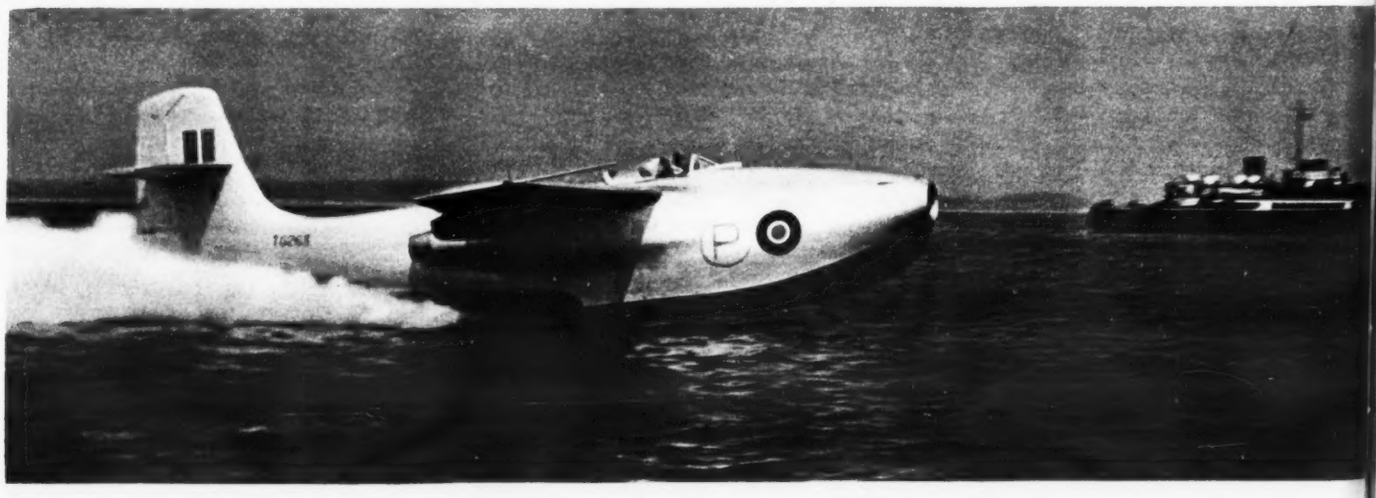
P.A.B.

Fighter Flying-Boat

A new aircraft category is coming into existence. The advent of the jet engine, which many scientists consider to be every bit as revolutionary as the invention of the steam engine over a century and a half ago, has enabled the British aircraft industry to create an aircraft type which could never have been built with the hitherto available means of propulsion. Admittedly, there used to be a time when the world's speed records were held by seaplanes ; but the conception of the flying-boat has never been coupled with the high speed and manœuvrability of the fighter.

Only in isolated cases have flying-boats proved useful in combat operations, primarily for long-distance reconnaissance missions, transport of men and material, and other similar duties. It is a fact that the air forces played a decisive part in the war against Japan. But they could not be put into operation until a sufficient number of aircraft carriers had been built ; and the ground forces could not advance until the air bases for the bombers had been erected or wrested from the enemy. It was the task of the carrier-borne fighter aircraft to prepare for the troops' step-by-step advance ; and it was land-based aeroplanes which subsequently, likewise step by step, carried out the attack against Japan.

After the war in the Pacific was over, we learned of the enormous expense involved in warfare of this nature. Even today, an estimate of the costs in men and material incurred by the air forces during their attacks over water against Japan can only be made by very initiated officials. The utilisation of landplanes over open sea entailed losses scarcely lower than those suffered in actual battle. If, in 1942, flying-



boats had existed with flying characteristics on a level with the landplanes, the air war in the Pacific might have assumed a rather different aspect. We only need to consider the vulnerability of aircraft carriers and the relatively small number of carrier-borne aeroplanes they are able to carry, in order to realise the simplifications which could have been brought about by utilising fighter and bomber flying-boats. Meanwhile, piston engines and airscrews necessitated that flying-boats be designed along lines which could never have provided the combat advantages of landplanes.

With the advent of the gas-turbine power plant, designers saw the chance of eluding mechanical complications such as canting engines and shaft drives ; and a few weeks ago the *world's first fighter flying-boat,* the *Saunders-Roe SR/A1,* made its initial flight.

The manufacturers, led by the chief designer, Mr. Henry Knowler, had set out to prove that a well-designed flying-boat incorporating an ingenious application of jet propulsion could meet almost all modern fighter requirements, despite the relatively bulky hull. This could only be achieved provided the armament and engines were completely housed inside the hull, designed according to hydrodynamic requirements, and by choosing a rather highly-loaded, high-speed aerofoil. For the power plant, choice was given to two Metro-Vick F2/4 "Beryl" axial-flow jet turbines, which are positioned side by side in the hull, with a common air intake at the bow of the boat making full use of the ram effect at all speeds. A ten-stage axial-flow compressor rotates at a maximum of 7,700 r.p.m., giving the "Beryl" a thrust of 3,850 lbs., according to the latest test bench trials ; diameter of the engine is 37.9 in. and weight, 1,750 lbs.

A further advantage of the side-by-side position of the two jet units is that it endows the flying-boat with extremely good single-engine flying characteristics. Apart from the obvious military value of this feature is the added advantage of cruising economy, making a considerably increased radius of action possible. Rather high fuel consumption is, naturally, one of the weak points of all modern jet-propelled aircraft ; the Metro-Vick "Beryl," on cruising power, consumes about 1 lb. an hour of fuel per 1 lb. thrust.

The wing, attached mid-to-high and measuring 415 sq. ft., has wing floats which are retractable in flight. In view of the high landing speed of flying-boats, the hull is very strongly constructed, with close-spaced frames and relatively light stringers. The cockpit is equipped with an emergency ejection seat and offers good pilot visibility in all directions. With a span of 46 ft., the single-spar trapezoidal wing has an aspect ratio of 5.1. In order to avoid damage to the engines from adverse spray, the cantilever tailplane, of which the leading edge features a slight sweepback, is attached halfway up the vertical stabiliser.

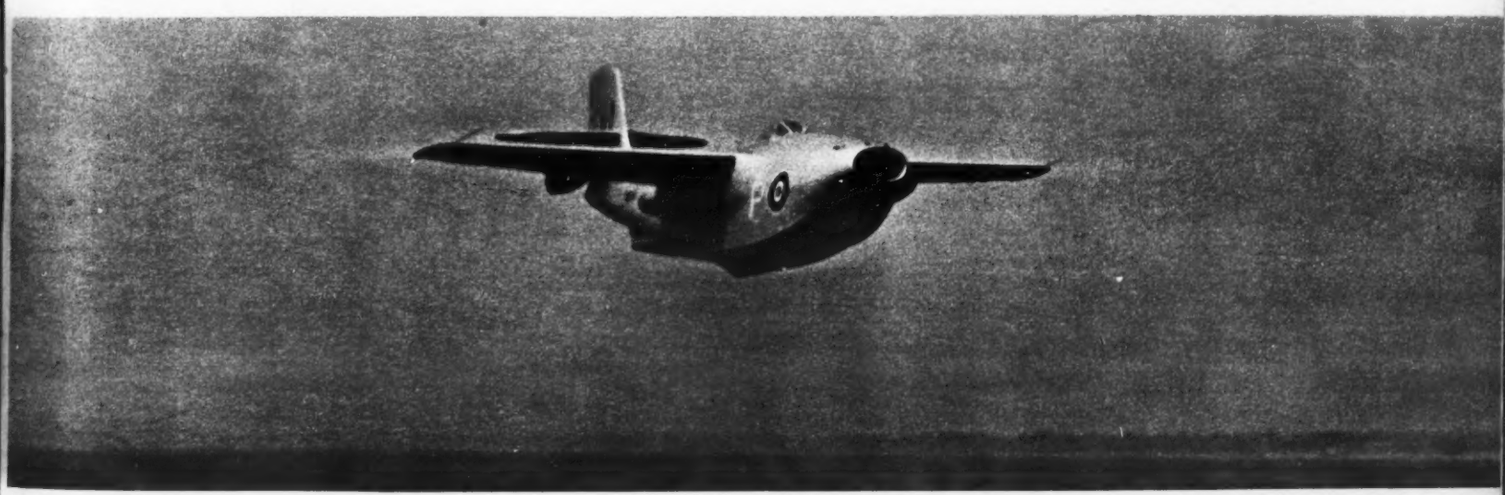
The hull, with its nose containing the air intake swept up to prevent water from entering, has a single step and measures 50 ft. in length. The jet outlets are located on either side of the fuselage, terminating aft of the wing trailing edge. The present armament consists of four fixed 20-mm. cannon, housed in the nose above the air intake ; the hull contains ample space for additional guns.

On July 16th, the Saunders-Roe SR/A1 fighter flying-boat took to the air for the first time and came well up to its designers' expectations. Only very few and insignificant modifications were necessary ; and two weeks later the aircraft could be flown before a wider section of the public. Weights and performances are still secret, but the demonstration revealed that the SR/A1 could take off in twelve seconds and can be expected to attain a top speed of about 500 m.p.h. The landing speed is approximately 100 m.p.h. and the approach speed about 125 m.p.h.

Although the new fighter flying-boat is not yet entirely seaworthy and its range is not quite up to R. A. F. wishes, credit must be given to the British aircraft industry, this time represented by Saunders-Roe, Ltd., for creating an altogether new and promising aeroplane category.

Bi.

Mr. Geoffrey Tyson, Chief Test Pilot of Saunders-Roe, Ltd., who is test-flying the new fighter flying-boat.



Arcata

BY ROBERT C. HARE, LOS ANGELES

Since March, 1945, the Army-Navy-Civil Landing Aids Experiment Station at *Arcata*, California, has been testing equipment designed to permit scheduled air operations under the most adverse weather conditions. To date the singular achievement of this government-civil sponsored project is the development of an *Integral Landing System*, which combines several partial answers to aviation's bad weather problems into one workable system. Experiments have been conducted under the supervision of former Commander R. L. Champion, U. S. Navy.

In addition to representatives of the Army Air Forces, Navy, Civil Aeronautics Board and Civil Aeronautics Administration, Air Transport Association and Air Line Pilots' Association, an airline company, United Air Lines, is also actively participating in the Arcata tests.

An air carrier such as United is in a position to appreciate fully the necessity for a unified and organised attack on the low visibility problem ; and its interest is sufficiently spurred by its own sad experiences with foul-weather operations. During 1946, this one airline spent, out-of-pocket, $ 150,000 for housing and feeding passengers at alternate terminals, providing surface transportation during bad weather, and other related expenses. An

Air view of the Landing Aids Experiment Station at ARCATA. Behind the horizontal blind-landing runway can be seen the tank farm for the FIDO fog dispersal unit.

estimated revenue of $ 2,300,000 was also lost as a result of flights being cancelled at the last minute because of poor weather.

The Integral Landing System developed at Arcata is made up of three basic components, all of which, it is pointed out, are either immediately available or in production today :

1. Electronic low-approach aids such as Ground Control Approach (GCA) or the Army's SCS-51 Instrument Landing System (ILS), either of which enable an aircraft to be brought safely down the runway approach zone at an altitude suitable for landing ;
2. High-intensity, controllable lighting, marking the approach and runway areas so as to give the pilot visual reference points for completing a contact landing ;
3. A fog dispersal system for operation during extremely poor visibility conditions so as to enable the pilot to see the final approach and runway areas whilst landing.

For *runway lighting*, choice has been given to the Bartow System, developed by Line Material Company, of East Stroudsburg, Pennsylvania, incorporating Bartow High Intensity Lighting Units with beam control[1] installed along both sides of the runway at 220-ft. intervals. Fresnel-type lenses concentrate the 500-watt light into a vertical beam of about 4 deg. height and 1 ½ deg. width. Distinguishing the threshhold, safe-landing area, and terminal section of the runway in accordance with the Army-Navy-Civil Standard Colour Sequence, the marker lights at the end of the runway are equipped with green filters and those bordering the 1,600-ft. terminal section have yellow filters. The intensity of the Bartow units is controlled by a resonant-circuit constant current regulator in steps of 30, 10 and 1 per cent.

Equipped with 500-watt lamps, the Bartow units permit pilots to land without difficulty in approximately 600 to 800-ft. visibility. Besides Arcata, the Bartow System for lighting runways is installed in at least eight other major U. S. airports.

Arcata *approach lights* were manufactured by the American Gas Accumulator Company, of Elizabeth, New Jersey, and installed in a funnel-shaped pattern beginning 3,000 feet from the runway threshold. This distance was based on a median figure of current aircraft approach speeds, 120 m. p. h., and on the time necessary for the pilot to re-adjust from instrument flying to contact flying. At this speed an aircraft will travel the 3,000-ft. approach zone in 17 seconds, which tests have shown to be adequate for final adjustments preparatory to a successful landing. Electronic analyses of glide path deviations conducted by the Army demonstrated that at the middle marker beacon used with ILS and located 3,500 ft. from the runway threshold, all pilots should pass through a rectangular portal extending from 100 to 500 ft. above runway level and spreading 350 ft. to either side of the approach centre-line. On the basis of these tests, the Arcata approach funnel was designed with the lighted rows 700 ft. apart at the entrance, with successive lights placed closer to the approach centre-line. For the remaining distance from a point 700 ft. from the runway, the converging light rows run parallel to the runway lights. At the critical approach end of the funnel, lights are located 100 ft. apart, measured along the funnel centre-line, for the first 600 ft., and spaced 200 ft. apart over the remaining distance. Because of the irregular terrain in the Arcata approach zone, the lights are mounted on towers varying from 7 to 84 ft. high, in order to maintain them at runway elevation.

The *AGA lights* are fitted with 5,000-watt lamps, controllable in intensity like the Bartow units. Reflectors produce a beam 35 deg. high and 45 deg. wide with the intensity at

[1] Cf. "INTERAVIA REVIEW" No. 3, March, 1947, P. 49.

The AGA lights are mounted on towers in order to maintain them at runway elevation.

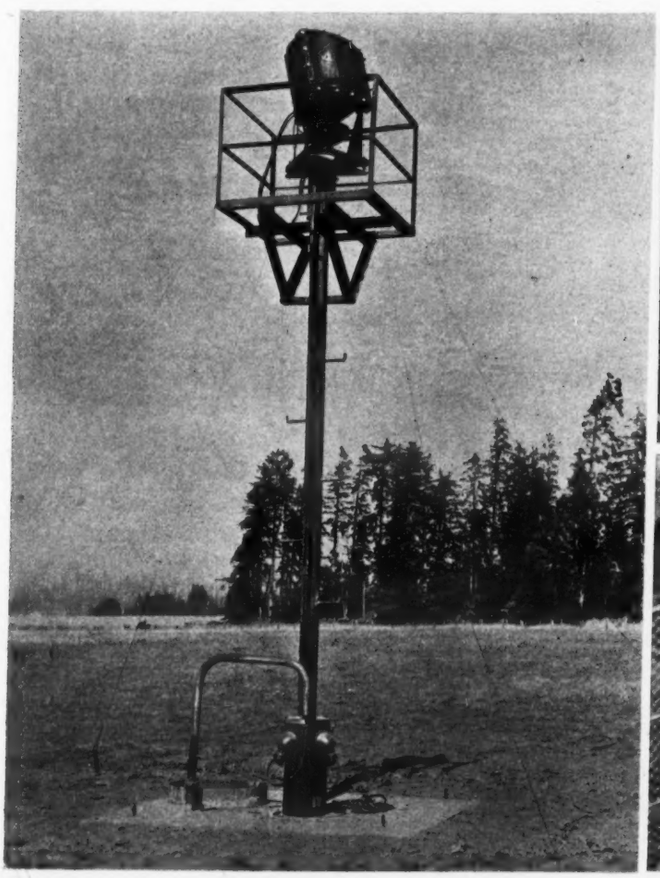
Dawn view of Arcata approach and runway lighting.

the edge of the rectangular beam attaining at least three-fifths of the maximum intensity. Aimed in such a manner that the outer edge of the rectangular beam is projected along the light row, the outer lights are, in addition, tilted upwards to cover the higher elevation of the glidepath at the approach end of the funnel. At the approach end, the lower edge of the beam is 10 deg. above horizontal and the top edge, 45 deg. The vertical angle decreases 1 deg. at each successive light, moving inward along the rows, until the lower edge is horizontal and the upper edge is 35 deg. The AGA lights in the Arcata funnel pattern assure that a pilot flying through a daylight fog with object visibility restricted to 1/8 mile will see at least three lights when his aircraft reaches a point 500 ft. from the nearest light, provided he is within the funnel and not more than 500 ft. above runway elevation.

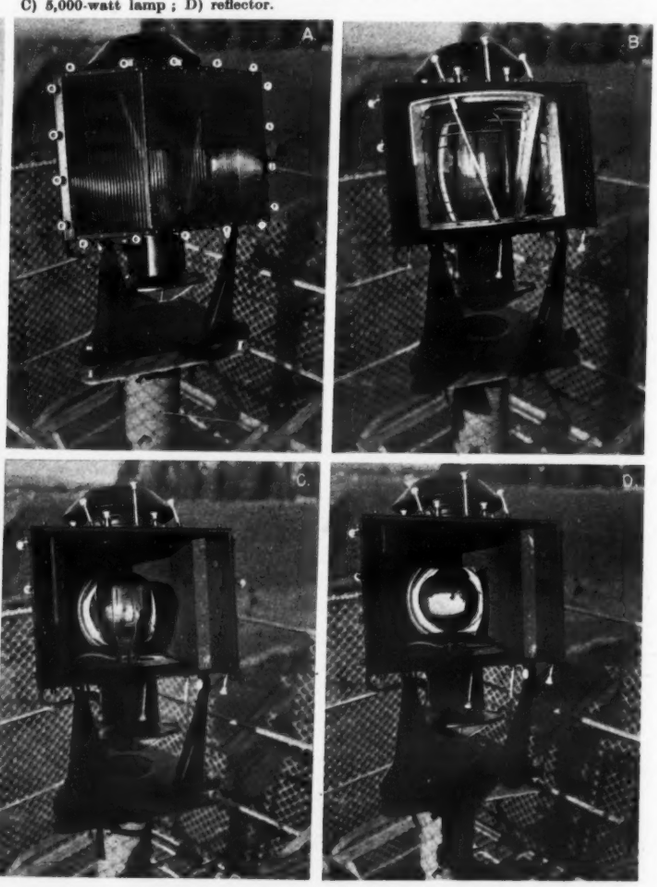
The backbone of the Integral Landing System developed at Arcata is formed by a *Blind-Landing System*, either the ILS (Army SCS-51) or GCA electronic system. Briefly, ILS[2] works as follows : A *Runway Localiser* installed at about 600 ft. beyond the end of the runway along the extended centre-line, transmits a carrier wave modulated with 150 and

[2] Cf. "INTERAVIA REVIEW" No. 8/9, Nov./Dec. 1946, P. 63.

AGA lights for approach zone.



Structure of AGA light : A) ready for operation ; B) with outer filter removed ; C) 5,000-watt lamp ; D) reflector.



90 c/s, which causes the vertical needle of the cross-pointer dial in the cockpit to deflect proportionately to the aircraft's deviation from the approach axis. At about 1,200 ft. up the runway from the threshold is the *Glide Path Transmitter*, which causes the horizontal needle to deflect, revealing the aircraft's deviation from the prescribed glide path. The pilot sees his exact distance from the runway touchdown point from three *Marker Beacon Transmitters*, beaming vertically upwards: the outer marker is 4 ½ miles from the threshold and is coded at two dashes a second; the middle marker, at 3,500 ft., produces six dashes a second; and the boundary marker, placed 200 ft. from the threshold, broadcasts a continuous signal. In order to simplify the pilot's transfer from instrument flying to contact flying and to place the entire manœuvre on an automatic basis, the Sperry Gyroscope Company has developed a device which automatically relays the impulses generated by the ILS airborne receiver to the automatic pilot equipment in the aircraft [3].

The redeeming feature of the GCA System as a component of the Arcata Integral Landing System is its ability to bring aircraft to contact landing position without added airborne equipment; thus it can serve more aircraft than ILS. The GCA unit at Arcata, which was obtained from Navy stock, is located 3,200 ft. from the runway threshold, 392 ft. to the left, viewed from the approach. This permits a touchdown point between 500 and 700 ft. from the approach end and clears the tower and hangars for precision scanning. The 3-deg. glide-path angle places the incoming aircraft about 35 ft. over the approach end of the runway. Of GCA's two separate radar devices, the "search unit" scans 360 deg. and locates all aircraft flying within 30 miles of the field. Commercially, this unit is indispensable for air traffic control, because the operator can safely direct a number of aircraft in the same general area while lining up for successive landings.

A second "precision" set of radar scopes for use in the approach zone scan an accurate region 20 deg. wide and 7 deg. high, showing aircraft/field relations in azimuth, altitude and distance. Manufactured for the military services during the war by Gilfillan Brothers, Inc., Los Angeles, the present GCA is mounted in a large trailer and requires five men to operate it. Currently, Gilfillan has a simplified one-man console GCA unit in production, suitable for control tower operation. Such sets have been installed in Washington, New York and Chicago at this writing, and are scheduled for installation in other major airports soon.

Third component of the Integrated Landing System developed at Arcata is *FIDO* [4], a number of which installations were completed early in 1945. Types experimented with were: Slot, Hades-Rapex, Haigill, PWD Non-Glare (burning vaporised gasoline) and, finally, the recommended Diesel oil-burning High Pressure system developed under Navy contract by the Babcock & Wilcox Company, of Baberton, Ohio.

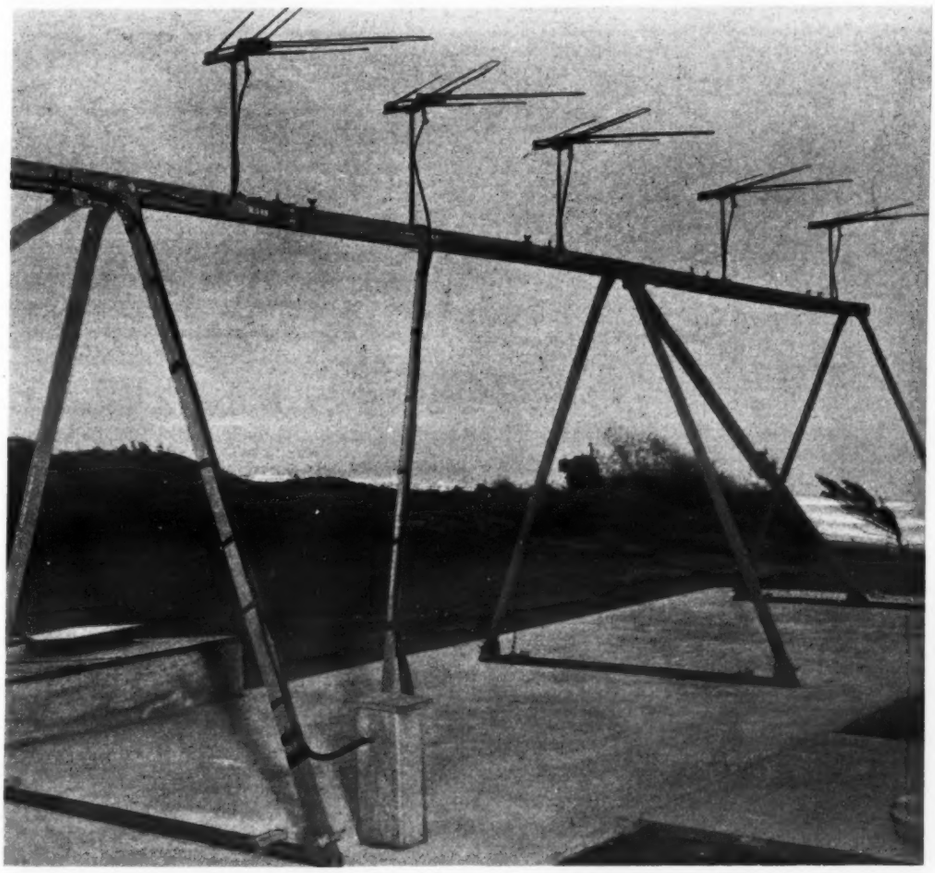
Not recommended at this time, but still under investigation at Arcata, are non-thermal

Bartow units for indicating the runway.

[3] Cf. *Sperry Microwave Instrument Landing System*, P. 39 of this issue.

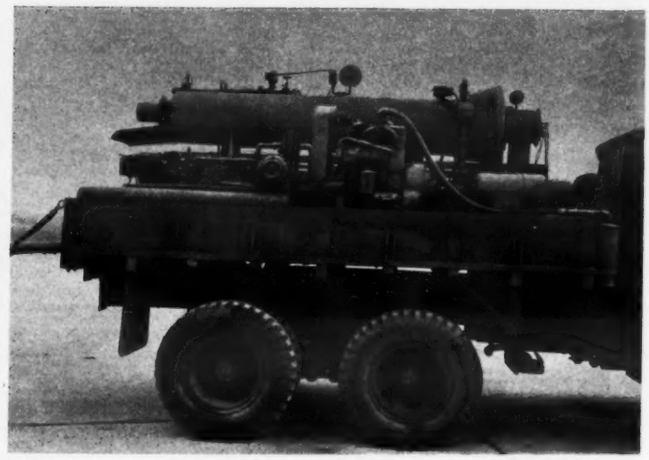
[4] Cf. "INTERAVIA REVIEW" No. 6, June, 1947, P. 43.

Antennae of ILS Runway Localiser.



Antenna of ILS Glide Path Transmitter.

Robert L. Champion, head of the Arcata Station, before the FIDO control panel.



Mobile device for atomising hygroscopic material: reducing the air humidity results in a decrease in fog density.

methods of fog dispersal. A sonic method of changing fog to rain by high-frequency sound-wave bombardment utilises twelve air raid type sirens at the windward end of the runway, designed to cause fog particles to merge and fall as rain. A wind curtain method which throws hot air at right angles to the wind, causing it to move in a vertical circle and thus dispersing fog, and a water curtain intended to cause the fog to merge with water, have also been tried. Calcium chloride has been found the most successful of a number of dessicants used to pick up atmospheric moisture. Non-thermal methods have given only very localised results, notwithstanding ambitious claims made for them from certain quarters.

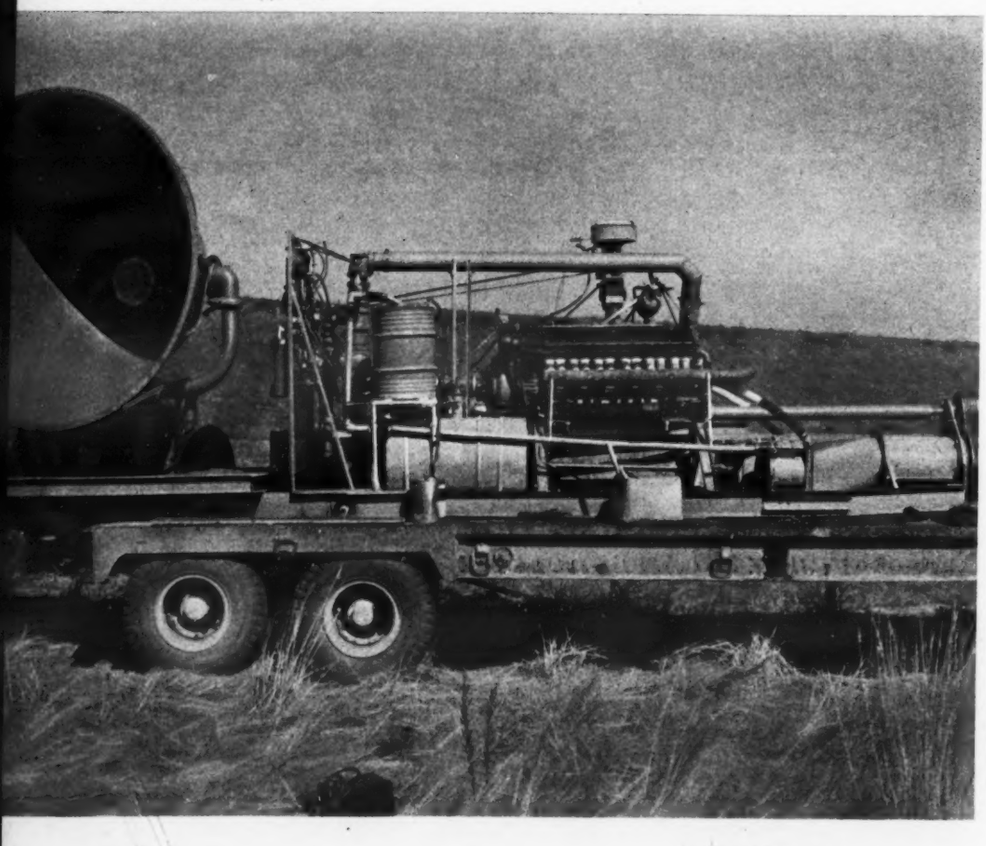
Tests of the Integral Landing System were held at Arcata during September and November, 1946, at all hours, day and night, whenever fog occurred. Of 110 approaches made in conditions of visibility varying from zero up to one mile, only five were unsuccessful, in that the test aircraft did not actually land. Anxious to try the System, the Arcata authorities authorised the tests when only 1,300 ft. of the approach light installation was operative. A full half of the flights were made under this condition. FIDO, in most cases, operated for only 600 ft., parallelling the approach ends of the runway rather than the 7,000 ft. recommended for a full installation. Finally, suitable monitoring equipment for the ILS radio beam was not available and the course could not be checked as accurately as would have been desired.

A cost estimate prepared by Arcata, covering installation of an Integral Landing System at Los Angeles Municipal Airport, typical of many coastal fog-band fields, comes to approximately $ 500,000. This may appear to be a large figure, but is actually a small percentage of funds already earmarked for airport improvement by Los Angeles. San Francisco recently voted a bond issue for $ 20,000,000 to cover airport improvement. Since busy airports such as these will each land tens of thousands of aircraft a year, amortisation of an Integral Landing System over a few years' operation will run but little higher than insurance against catastrophe. Experience demonstrated at Arcata that five men can maintain and operate FIDO, approach and landing lights, and check ILS. With the new Gilfillan console GCA unit, one additional operator might be required in the control tower of an unusually busy field.

Although the ultimate objective of the Army-Navy-Civil Landing Aids Experiment Station may not be achieved for several years, enough progress has been made to recommend the Integral Landing System as an interim solution to today's problem, by reducing accidents owing to bad weather and increasing the reliability of scheduled air operations. U. S. airline records show that they suffer a loss of $ 22,000,000 yearly because of non-productive equipment and personnel rendered inoperative during bad weather, not counting crashes which cost at least $ 1,000,000 for each DC-3 lost with all passengers, and loss of good-will.

As continued research at the Landing Aids Experiment Station brings forth increasingly significant contributions to the safety of the world's airlines, Arcata will take its place among the great scenes of aviation progress along with Kitty Hawk and Wright Field.

Arcata is testing a sonic method of changing fog to rain by high-frequency sound-wave bombardment, which uses twelve air raid type sirens.



Economic Aspects of the American Aviation Industry

V *

The United States airlines are showing evidence of emerging from the serious difficulties of the last year. For May eleven out of seventeen major domestic airlines were in the black, although for the five months up to and including May, only two lines showed a profit. Some degree of confidence in the overall outlook has been expressed by leading students of the industry in recent months. Individuals willing to take the long-range viewpoint are generally satisfied with the progress that has been made and the prospects for further progress over the next several years. The following figures show revenue passenger miles flown since 1930 :

AIRLINE OPERATIONS IN THE UNITED STATES

Year	Revenue Passenger Miles Flown (000)	Year	Revenue Passenger Miles Flown (000)
1946	5,947,047	1937	407,296
1945	3,362,456	1936	388,242
1944	2,229,571	1935	279,376
1943	1,606,119	1934	187,859
1942	1,398,042	1933	173,492
1941	1,369,584	1932	127,039
1940	1,041,174	1931	106,442
1939	677,673	1930	84,015
1938	476,402		

Estimates for this year indicate a figure of about 7.5 billion revenue passenger miles and conservative predictions place 1950 traffic at above 11 billion revenue miles. Since that figure is over 100 times the level in 1930, the really extraordinary progress of the U. S. air transport industry is apparent. The prediction of 11 billion revenue passenger miles by 1950 may be on the low side. Also mail, express and freight tonnage should increase at a considerably faster rate then passenger traffic.

While the air transport industry has grown tremendously since 1930, it is still comparatively small. With approximately 100,000 domestic route miles operated, compared with over 230,000 route miles operated by the railroads and with only 1.5 % as many revenue passengers as carried by Class I railroads, the industry, by any standards, must be classed as small. Total airline employees of about 70,000 compare with over 1,300,000 railroad employees ; and investment capital of the air transport industry of about 250 million compares with investment capital of the Class I railroads of about 25 billion.

While there are approximately 700 planes in scheduled domestic operations and perhaps another 200 in foreign service, the railroads have over 40,000 passenger and pullman cars. In comparison with the total transportation, including private automobile and bus, the figures for the air transport industry would be even more modest.

For relatively undeveloped areas of the world, such as portions of Asia, South America and Africa, transportation is developing rather suddenly, from relatively primitive methods to modern air transports. In those areas it now appears likely that the networks of railroads which characterise Europe and the United States will never be built and that air transportation will be relatively free of competition as far as passengers and high value commodities or mail and express are concerned

In the United States, if there is an overflow of airline traffic or cancellation of airline flights because of weather conditions, the traffic can usually be easily diverted to the railroads. This means that the airlines are able, if they so desire, to operate equipment with a relatively high utilisation, knowing that the railroads will be equipped to handle the peak load. Where the airline is the only form of long-distance transportation, adequate service to the public means equipping for peak traffic loads and probably means a lower overall occupancy factor than is possible where the airlines carry a relatively small percentage of traffic. On the other hand, where the airline industry has a semi-monopolistic position, they can ask, and obtain, higher rates than where rail competition exists as in the United States.

The effect of competition from alternate means of transportation has been illustrated by the course of air travel in June and the first half of July, following the three serious airline accidents in the latter part of May and the early part of June. The long-haul traffic, particularly west of Chicago, did not decline materially, but the short-haul traffic on the east coast and east of Chicago fell off noticeably. The reason is obvious : if a passenger from New York to Detroit is worried about the safety of air travel, he is likely to cancel his airline reservation, take the " Detroiter " and enjoy a comfortable overnight trip to the " Motor City " ; for the prospective passenger from Chicago to Los Angeles, which is a six-hour flight, the traveller must be of a rather nervous nature to be convinced that he should undertake the approximately 48-hour train trip. The relatively high load factors on long-haul transcontinental flights in recent months have further favoured such companies as United Air Lines, as against the relatively short-haul carriers such as Pennsylvania Central, where load factors are down materially.

In addition to the very real competition from railroads, who do not intend to surrender their passenger business meekly, competition between thousands of miles of parallel airline routes, which have been awarded in recent years, is becoming more intense. Because of restricted finances, several United States airlines are on the brink of insolvency and it does not seem likely that all airlines will manage to steer clear of financial difficulties. Investors willing to hold air transport securities because of their favourable long-term aspects, and because of recently-improved operations, should favour well-financed companies such as United Air Lines, Eastern Air Lines, and American Airlines, on the theory that these are best equipped to compete successfully, to avoid financial difficulties. The financial problems of even such large carriers as Transcontinental & Western Air are the subject of concern not only to investors, but also to the government, which has always taken a paternal attitude towards this young industry, so vital to national defence.

The table on the next page shows recent earnings and market price figures for the principal airline equities.

* Cf. IV in No 7, Vol. II.

	May, 1947			5 months up to May, 1947				
	Gross Rev. (000)	Net Open Income (000)	Ind. Net per sh.	Gross Rev. (000)	Net Oper. Income (000)	Ind. Net per sh.	Current Market	1947 Range high-low
American Airlines	$ 7,741	$ 726	$ .06	$ 30,389	d $ 4,130	d $.50	8 3/4	11 3/8— 8 1/8
American Overseas	2,068	259	.14	6,504	d 2,013	d 1.20	8 1/4	9 1/4— 6 3/4
Braniff Airways	990	27	.05	4,153	d 607	d .52	9	13 1/2— 8 3/8
Colonial Airlines	247	d 67	d .12	991	d 551	d 1.09	7 5/8	11 3/4— 7 1/2
Chicago & Southern	752	d 16	d .03	3,161	d 603	d 1.09	6 1/8	9 1/8— 5 5/8
Continental Air Lines	334	d 15	d .04	1,386	d 303	d .92	8 1/8	11 — 6 1/2
Delta Air Lines	993	27	.02	4,713	d 103	d .23	22 1/2	27 —18 1/2
Eastern Air Lines	4,444	673	.17	21,893	3,590	.84	18 7/8	24 1/4—17 1/4
Inland Air Lines	207	35	.21	748	d 27	d .12	4	6 — 3
Mid-Continent Airlines	484	12	.02	2,014	d 120	d .18	7 3/8	8 1/4— 6
National Airlines	919	d 45	d .04	4,963	410	33	11 3/4	16 1/2—11 3/8
Northwest Airlines	1,922	d 25	d .20	7,332	d 2,248	d 2.88	12	22 1/4—12
Northeast Airlines	325	d 107	d .13	1,525	d 691	d 1.26	4	7 3/8— 3 1/2
Penn.-Central Airlines	1,903	90	.06	6,861	d 2,109	d 5.50	7 1/4	15 1/2— 6 1/4
Transcontinental & West. Air	6,873	245	.16	25,724	d 5,260	d 5.77	14 3/4	22 7/8—13 1/2
United Air Lines	6,373	632	.26	23,630	d 4.815	d 1.77	21 3/4	28 1/2—21
Western Air Lines	1,048	121	.21	4,338	d 516	d .93	7	10 1/8— 5 3/4

d = deficit.

With the final merger of the United States military forces under a Secretary of National Defence, a 30 year old dream of Army airmen has come true. This is the dream of a separate independent United States Air Force, answerable neither to the Army nor the Navy. The merger of the air forces is the means of fulfilling the air forces' objective. In this union the air forces will have a chance to develop their own theories of air power. They will be allocated more money than either the Army or Navy. They gain the status of the first line of national defence, a position formerly enjoyed in peacetime by the Navy.

The following is the text of President Truman's directive on operation of the Air Force in the national military establishment, set up by the Armed Services Merger Act.

" The United States Air Force includes all military aviation forces, both combat and service, not otherwise specifically assigned. It is organised, trained, and equipped primarily for prompt and sustained air offensive and defensive operations. The Air Force is responsible for the preparation of the air forces necessary for the effective prosecution of war except as otherwise assigned, and, in accordance with integrated joint mobilisation plans, for the expansion of the peacetime components of the Air Force to meet the needs of war.

Specific Functions of the Air Force

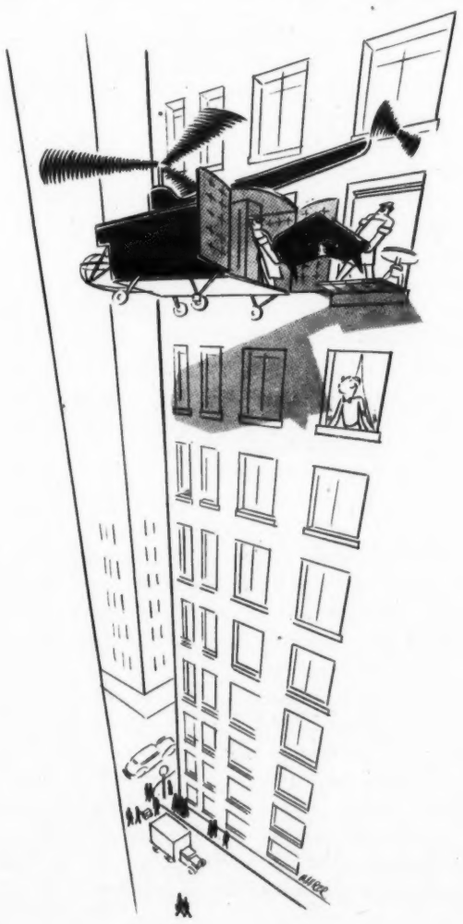
1. To organise, train and equip air forces for : (A) air operations including joint operations ; (B) gaining and maintaining general air supremacy ; (C) establishing local air superiority where and as required ; (D) the strategic air force of the United States and strategic air reconnaissance ; (E) air lift and support for airborne operations ; (F) air support to land forces and naval forces, including support of occupation forces ; (G) air transport for the armed forces, except over routes solely of interest to naval forces where the requirements cannot be met by normal air facilities.
2. To develop weapons, tactics, technique, organisation and equipment of air force combat and service elements, coordinating with the Army and Navy on all aspects of joint concern, including those which pertain to amphibious and airborne operations.
3. To provide, as directed by proper authority, such missions and detachments for service in foreign countries as may be required to support the national policies and interests of the United States.
4. To provide the means for coordination of all defence among all services.
5. To assist the Army and Navy in the accomplishment of their missions, including the provision of common services and supplies as determined by proper authority. "

This change in the status of the air forces promises increasing military orders for leading aircraft manufacturing companies. How soon the Air Force plans will be reflected in the income accounts of the aircraft industry is still a matter of some confusion and disagreement. While observers have generally agreed that the actual consummation of the programme is favourable, most aircraft manufacturing executives seem to feel that 1947 will be a difficult year and that 1948 is the earliest for direct benefits in the form of government production contracts to be important. At a recent meeting of the East Coast Aircraft Council, Major General O. P. Echols, President of the Aircraft Industries Association, said about 3,000 planes a year, aggregating about $ 1.5 billion, would sustain the 14 present manufacturers, especially if they can project their plans on a five-year programme. The industry feels that, with the President's appointment of the new five-man Morrow Board and the Senate Appropriations Committee's increase in the aircraft procurement programme (which is meeting opposition in the House), prospects for the manufacturing industry are improving. Indications for actual orders for the next twelve months, however, are for considerably fewer aeroplanes than for the 3,000 plane minimum objective of industry.

Meanwhile, the problems of the aircraft manufacturing industry have resulted in continuing pressure on the principal equities, which have failed to rally in the recent market advance to the same extent as equities in other industries such as the petroleum industry or the chemical industry, where the outlook is more clearly defined.

August 1st, 1947.

Baker, Weeks & Harden,
Wall Street.
(Jeremy C. Jenks.)



THE MONTH IN REVIEW

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POLITICAL

● In protest against the belligerent attitude of Holland in Indonesia, the Union of India *prohibited all Dutch civil aviation traffic to and across India.* Similar action was also taken by the *Pakistan* Government, with result that *KLM Royal Dutch Airlines* were compelled to cancel their Amsterdam-Batavia service on August 3rd. After KLM had found a way of avoiding intermediate landings on Indian territory, by operating from Amsterdam to Batavia via Colombo, the Government of *Ceylon* joined the Indian and Pakistan Governments in forbidding landings on its territory.

● Following the authorisation of Italian airline services abroad, the *Italian Government has decided to request reciprocal rights from all countries granted entry and transit rights by Italy.* This would enable Italian aircraft to fly to Sweden, Norway, Denmark, Holland, Belgium, France, Spain, Great Britain, the United States, Venezuela, Colombia, Brazil and Argentina.

● CIVIL AVIATION AGREEMENTS have been concluded between : *France and the Union of India,* on July 16th in New Delhi ; *Great Britain and China,* on July 23rd in Nanking ; *Holland and the Union of South Africa,* on July 23rd in Pretoria ; *Great Britain and Canada,* on July 25th in Ottawa (concerning route allocations between Canada and the British Colonies of Bermuda, Jamaica and Trinidad) ; *Chile and Brazil,* in Rio de Janeiro ; *Canada and Ireland,* on August 9th in Dublin. Air pact negotiations are in progress between Norway and France.

NEW AIRCRAFT

● The Glenn L. Martin Co. subjected their *Martin 3-0-3* twin-engined commercial transport, pressurised version of the Martin 2-0-2, to its *first flight on July 3rd* over the firm's airfield at Baltimore. O. E. Tibbs, Martin's Director of Flight, was at the controls.

● Kellett Aircraft Corp., of Philadelphia, have developed a large helicopter, the *Kellett XR-10,* for the U. S. Army, of which the prototype made its *first flight on July 13th.* The XR-10 accommodates ten passengers, has two contra-rotating, inter-meshing three-blade rotors located over the fuselage, and is externally similar to a experimental two-seater helicopter developed by this firm, the Kellett XR-8. Power plant consists of two air-cooled radial engines of 525 H.P., of which the make is not stated. Weighing about 11,000 lbs. gross, the XR-10 is reported to have a maximum speed of over 100 m.p.h., a cruising speed of 90 m.p.h., and a range amounting to 350 miles.

Kellett XR-10 twin-engined helicopter.

* Excerpts from Nos. 1336-1346 (July 19th to August 12th, 1947) of "INTERAVIA, International Correspondence on Aviation," an illustrated newsletter published thrice weekly in four language editions, English, French, Spanish and German.

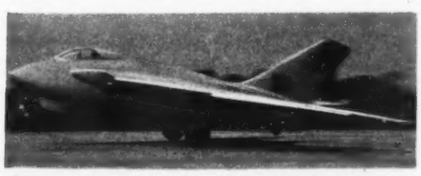
● Short Bros. (Rochester & Bedford), Ltd., have almost completed the *second prototype of the Short S-35 "Shetland"* four-engined flying-boat. It will be recalled that this second prototype is of the civil version ; the first prototype, of the military version, was destroyed by fire on January 28th, 1946.

Short "Shetland" flying-boat nearing completion.

● *Tony LeVier and Associates,* a small firm formed by a group of U. S. test pilots and engineers, has developed a light racing aircraft, the *"Cosmic Wind,"* which has been specially designed for entry in one of the races in this year's Cleveland Air Races for a newly-created class of light racing aircraft. Interestingly, the wing is a scaled-down version of that of the Lockheed P2V "Neptune" twin-engine long-range reconnaissance aircraft. It weighs 800 lbs. and has a wing span of 19 ½ ft. Powered with an 85-H.P. Continental air-cooled flat-four, it has a maximum speed of 200 m.p.h.

"Cosmic Wind" light racing aircraft.

● The third prototype of the *de Havilland D.H. 108 "Swallow"* experimental all-wing jet aircraft made its *first flight on July 24th,* thus resuming the test flight programme interrupted by Geoffrey de Havilland's fatal accident with the second prototype on September 27th, 1946. The aircraft was piloted on this occasion by John Cunningham, the firm's chief test pilot. The only basic design modification featured by the third prototype is a replacement of the earlier wooden nose by a slightly more pointed metal one.



Third prototype of the de Havilland 108 "Swallow."

● The French national *SNCA du Sud-Ouest* aircraft manufacturing concern is developing a twin-jet bomber, the *SO 4000,* for which the SO M1 experimental aircraft exhibited at last year's Paris Salon is serving as flying model. The SO 4000 is to be an all-metal mid-wing monoplane with swept-back wing. Power plant is to consist of two Rolls-Royce "Nene" turbo-jet engines positioned on either side of the fuselage beneath the wing, with a common jet orifice in the fuselage tail. The crew is to consist of a pilot and a navigator. The span of the SO 4000 will be 58 ft. 6 in. ; length, 59 ft. ; and weighing 57,200 lbs. all-up, it is expected to attain a maximum speed of 560 m.p.h. at 32,800 ft. altitude.

● The prototype of the *Aero 45,* a twin-engined four-seater tourer and feeder aircraft developed by the Czech firm of *Vysocany* (formerly Aero), made its *first flight on July 21st.*

Aero 45 four-seater personal aircraft.

● The *Bristol 171,* a four-seater helicopter developed by The Bristol Aeroplane Co., Ltd., made its *first flight on July 25th* from Filton Airport. Designed by Raoul Hafner, the Bristol 171 is to be used for charter services.

● The *Boulton Paul P. 108 "Balliol"* a three-seater trainer developed for the R. A. F. by Boulton Paul Aircraft, Ltd., which is to be powered with a propeller-turbine, was *recently test-flown* with a Bristol "Mercury" air-cooled nine-cylinder radial fitted, as the gas turbines were not available. Now that the prototype has completed its first flight tests, it is being fitted with an Armstrong-Siddeley "Mamba" propeller-turbine of 1,000 H.P., as originally intended.

Boulton Paul P. 108 "Balliol" trainer.

● A newly-developed single-seater jet fighter, the *"Pulque,"* is approaching completion at the *Instituto Aerotécnico de Córdoba,* the Argentine aircraft manufacturing concern, and should start its first test flights shortly. It is an all-metal low-wing monoplane powered with a Rolls-Royce "Derwent" jet-engine which is expected to give it a maximum speed of over 500 m.p.h. Its gross weight is 7,935 lbs. and it has a wing span of 36 ft.

● The U. S. Aircraft Industry is developing several *new fighters for the Army Air Forces,* all of which are jet-propelled. McDonald Aircraft Corp. is developing the *McDonald XP-88* single-seater fighter, which is to be powered with two Westinghouse 24C turbo-jets mounted in the lower side of the fuselage, and has a design speed of over 700 m.p.h. It has a swept-back wing and swept-back combined V-type tail unit, and is expected to take to the air before the end of 1947. — The *Northrop XP-89* is an all-wing fighter which is a military version of the Northrop XS-4 experimental

supersonic aircraft. It is to be fitted with two General Electric J-35 turbo-jets. Lockheed Aircraft Corp. is developing a supersonic interceptor fighter, the *Lockheed XP-90*. Its power plant will comprise two Westinghouse 24C turbo-jets and two rocket motors, the turbo-jets being for normal flight and the rocket engines for take-off, climbing and short bursts of power in level flight. — Another supersonic fighter is the *Republic XP-91*, being developed by Republic Aviation Corp. This will be powered with a special version of the General Electric J-35 turbo-jet with water injection, which is expected to deliver double the thrust of the standard engine. Four large and two small rocket engines will be used for take-off climbing, and for accelerating the aircraft through the sonic barrier. Finally, Consolidated Vultee Aircraft Corp. is building the *Convair XP-92*, likewise a supersonic fighter, of which the power plant differs from the last-named types in that it has rocket motors as its main source of power and two Westinghouse 19B turbo-jets merely for cruising.

INDUSTRY

● The *Argentine Air Department* has placed an order in Italy for 43 *Fiat G 55* fighter trainers, costing between Pesos 60,000 and 70,000 and for delivery within a year. The Air Department is also believed to be interested in the *Fiat G. 212* three-engined commercial transport.

INDUSTRIAL PERSONALITIES

● On July 17th, *Edgar N. Gott*, pioneer of U. S. aircraft industry, died in San Diego, Calif., aged 60. One of the founders of Boeing Airplane Co. in 1915, he was the firm's General Manager for eight years and its President for two. He subsequently held top executive positions with Fokker Aircraft Corp., Keystone Aircraft Corp., and Consolidated Aircraft Corp. Upon his retirement in 1944, he was Assistant to the President of Consolidated-Vultee Aircraft Corp.

AIR TRANSPORTATION

● The Civil Aeronautics Administration reports that the total number of *civil aircraft registered in the U. S. A. by July 1st, 1947*, was 93,920, against 57,488 on July 1st, 1946. Of these, 902 (706) were scheduled carrier aircraft. *Airports in operation* in the U. S. A. on July 1st numbered 5,251, compared to 4,306 one year beforehand.

● U. S. Airline companies re-equipping with *"Convair-Liners"* and *Martin 2-0-2's and 3-0-3's* are worried about the *increased runway requirements* of these aircraft compared with the DC-3. *American Airlines*, for instance, has informed 17 cities on its route network that it may not be able to serve them when it replaces its DC-3's with "Convair-Liners" unless they increase their runways to at least 4,500 ft. *Western Air Lines* is considering carrying fewer passengers to airports where the runways are of marginal length, rather than not to fly at all. A solution to the take-off problem of short runways might lie in the *JATO take-off rocket*, for which it is expected that the CAA will grant a type certificate shortly.

● In view of the continuing unsatisfactory load factors on the *U. S. domestic airlines* since the crash series of last spring, serious consideration is being given to seeking a *further increase in passenger rates*.

● The Port of New York Authority has estimated that foreign air freight will be seven times the present volume by 1955 and thirteen times by 1960. For this reason, it is planning a *special separate freight terminal at Idlewild Airport*.

● The journey from *New York to Buenos Aires* may now be made in an elapsed time of *24 hours 40 min.*, since the introduction of a non-stop New York—Miami service by *National Airlines* with Douglas DC-6's connecting with *Pan American Grace Airways'* Miami—Lima—Santiago—Buenos Aires service (also operated with DC-6's).

● The Inter-American Safety Council has awarded *Compania Cubana de Aviacion S. A.*, the Cuban airline, a *world record for safety* for operating over a period of twelve years (1935-1946) 148,870,382 passenger-miles without an accident.

● A new airline company has been formed in Panama, *Compania Panamena de Aviacion (COPA)*, with Pan American World Airways holding a one-third interest. The Panama Government has entrusted all domestic and cargo transportation to the new carrier.

● The *15 per cent Canadian transportation tax has been lifted* from routes to distant parts of the country for which there are no practical means of surface transportation.

● Following Canada's plan to have British emigrants flown out to Canada, Australia is now negotiating with a U.S. charter concern to arrange for the acceleration of the *transportation of British emigrants to Australia*.

● On July 18th there were *1,238 civil aircraft registered* with the British Air Registration Board, an increase of 758 during the year. The number of pilots' "B" (private) licences also showed a large increase, 1,555 issued and 1,196 extended.

● *British European Airways Corp.* has ordered *200 miniature Gee radar sets* for installation in new types of aircraft. The new set weighs only 25 lbs., against the 60 lbs. of the set used by the RAF during the war, and production is to start this year.

● Since the introduction of its summer timetables on May 19th, *British European Airways Corp. has eliminated the provision of free meals* to passengers on its routes.

● *British European Airways Corp. has taken its 11 Junkers Ju. 52's off its internal routes*, on which they were introduced last spring. As their conversion cost about £ 140,000, it seems that they will have to be used for some other purpose, possibly for the Ministry of Civil Aviation's projected night airmail services.

● It was stated in the House of Commons that, in the *first six years* of its existence, April 1st, 1940 to March 31st, 1946, *deficiency grants to British Overseas Airways Corp. totalled £ 11,607,406*.

● Air Vice-Marshal Sir William Tyrrell, Director of Medical Services of British Overseas Airways Corp., stated in London on July 8th that the "ceiling age" for commercial pilots was 50. At 40, a pilot requires special attention, although most were found fit enough to carry on ; at 45, however, 80 per cent were grounded and the remainder subjected to intensified medical tests.

● *United Air Lines* and *KLM Royal Dutch Airlines* have agreed to act as *each others' agents in Holland and the U. S. A.* Thus KLM's 70,000-mile network serving 57 cities on 5 continents is linked with UAL's 11,553-mile network serving over 70 cities in the U. S. A., Canada and Hawaii.

● On August 2nd the Dutch Senate approved *State participation to the extent of Fl. 51,000,000 in KLM Royal Dutch Airlines*.

● *Sabena*, the Belgian national airline company, has ordered *six "Convair-Liner"* twin-engined transports. It is expected that one will be delivered in February, two in March and three in April, 1948.

● *American Overseas Airlines* now offers *single-ticket services to Zurich and Basle*, Switzerland, and to *Prague*, Czechoslovakia, from any point on American Airlines' and its own routes.

● The fees for the utilisation of State airfields in Italy have been made ten times higher.

● *A. B. Aerotransport (ABA)*, the Swedish carrier, has *increased its fares by 10 per cent on all domestic services*. Ascribed to the increase in landing fees in the Scandinavian countries and to the increased price of fuel, the new fares also apply to the Stockholm—Oslo and a Stockholm—Copenhagen services.

● AIRPORTS : Denmark is making the former Luftwaffe base at *Tirstrup*, 30 miles from Aarhus, the *third Danish international airport ;* the other two are Kastrup Airport, Copenhagen, and Aalborg Airport, which is being extended. — On July 25th *Ciampino Airport*, Rome, was handed over to the Italians by the U. S. Authorities. Likewise handed over was a large quantity of bulldozers and other engineering equipment worth many thousands of dollars, so that the airport may be maintained and expanded into a *intercontinental facility*. It is planned to lay down a new concrete runway for heavy transport aircraft.

AIRLINE PERSONALITIES

● On August 1st, 1947, *Scandinavian Airlines System (SAS)*, the joint group of Nordic carriers, *ended its first year of existence*. As was to be expected, the event was marked by a number of new appointments : the post of *Chairman of the Board of Directors*, hitherto held by Per Kampmann (DDL), has been assigned to *Ths. S. Falck, Jr.* (DNL), who was Vice-Chairman during 1946 : *M. Wallenberg (SILA)* is the new *Vice-Chairman*. *Per A. Norlin* (SILA) has been made *President* of SAS.

● *British European Airways Corp.*, which expects to receive its first Sikorsky S-51 helicopter in September, two further S-51's and two Bell 47B helicopters before the end of the year, has set up an *Experimental Helicopter Unit*. This is headed by *Wing Commander Reginald Brie*, the well-known specialist on rotary wing aircraft, and A. McClements is Experimental Engineer.

SERVICE AVIATION

● The *French Air Force is equipped entirely with foreign aircraft*, but it is hoped the sufficient French aircraft will be available by 1951, according to the French Air Minister, André Maroselli, on August 2nd.

AVIATION LITERATURE

● The European Regional Traffic Conference of the International Air Transport Association in Estoril, Portugal, from February 4th to 8th, 1947, decided to issue a *European Timetable* with schedules, fares and main connections of the IATA member companies. This timetable is to be *published jointly by Etablissements Chaix*, of Paris, and *Interavia S. A.* of Geneva.

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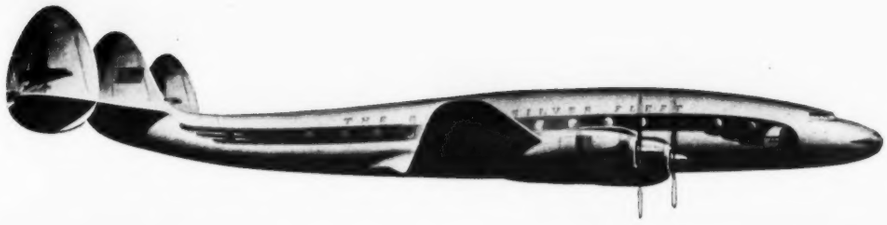

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